Inquiry on Federal Water Policy

Enquête sur la politique fédérale relative aux eaux

Research Papers

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CANADIAN INTERBASIN DIVERSIONS

by

J.C. Day

Canada

Inquiry on Federal Water Policy
Research Paper # 6

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Natural Resources Management Program
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THE INQUIRY ON FEDERAL WATER POLICY

The Inquiry on Federal Water Policy was appointed by the federal Minister of the Environment in January of 1984 under the authority of the Canada Water Act. The members were Peter H. Pearse, chairman; Françoise Bertrand, member; and James W. MacLaren, member. The Inquiry was required by its terms of reference to review matters of water policy and management within federal jurisdiction and to make recommendations.

This document is one of a series of research papers commissioned by the Inquiry to advance its investigation. The views and conclusions expressed in the research papers are those of the authors. Copies of research papers and information on the series may be obtained by writing to the Enquiry Centre, Environment Canada, Ottawa, Ontario K1A 0H3.

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Director of Research

Abstract

Canadians have long experience in interbasin water transfer on which to base judgements concerning the desirability and management of future projects. Enormous progress was made in planning hydroelectric diversions over the past four decades. From an initial emphasis on engineering, geotechnical, and economic concerns in the Ogoki, Long Lake, and the first phase of the Kemano projects, gradually biophysical and social questions received increased attention and more sensitive treatment in the Churchill-Nelson, James Bay, and Kemano Completion projects. But more effective institutional arrangements are needed to reconcile federal and provincial management responsibilities, particularly in the interjurisdictional setting of shared river basins. Before initiating any large-scale diversions of Arctic waters, studies are needed to define potential effects on climate and marine environments. The potential for detrimental change due to biota transfer when major drainage divides are crossed also requires investigation. Enormous overbuilding of diversion-related hydroelectric capacity has been costly to the Canadian public. More equitable treatment of native groups negatively affected by diversions is a major need in future projects. The long-standing Canadian federal policy which has consistently opposed water export without supporting evidence needs to be rethought.

Résumé

Les Canadiens ont une longue expérience dans le domaine de la dérivation des cours d'eau; il peuvent s'appuyer sur cette expérience pour juger de la désirabilité et de la gestion de projets futurs. Des progrès énormes ont été accomplis au niveau de la plannification des projets de dérivation, à des fins de production d'électricité lors des quatres dernières décennies. Les préoccupations, de nature purement logistiques, géotechniques et économiques qu'elles étaient lors des premiers projets (Ogoki, Long Lake, première phase du projet Kemano), ont graduellement évolué pour inclure les aspects biophysiques et sociaux comme ce fut le cas pour les projets Churchill-Nelson, de la Baie James et pour le projet de parachèvement Kemano. Des arrangements institutionnels plus efficaces sont cependant requis afin de réconcilier les responsibilités fédérales et provinciales, particulièrement dans le cas de bassins de nature interjuridictionnelle. Avant que des projets de dérivation à grande échelle des eaux artiques soient initiés, des études sont requises afin d'en identifier les effets potentiels sur le climat et l'environnement marin. La possibilité de dommages causés par le transfert de biota lors de dérivations entre des bassins biologiquement différents demande aussi d'être étudiée. L'énorme surplus de capacité résultant de projets hydroélectriques avec dérivations a été couteûx pour le public canadien. Un traitement plus équitable des autochtones affectés de façon négative par les dérivations est requis lors des projets futurs. La politique fédérale canadienne de non-exportation d'eau établie il y a de cela longtemps et sans preuves à l'appui doit être repensée.

Acknowledgements

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I am deeply indebted to Judy Runzer for her patience in typing the many drafts of this report and to Ray Squirrel and Margaret Wheat for preparing the figures.

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Units

Some basic units used in this report include:

volt	V	
watt	W	
hour	h	
meter	m	cubic meters m^3
kilometer	km	cubic kilometers $km^3 = 10^9 m^3$
hectare	ha	$= 10{,}000\ m^2$

Prefix	Exponent	Symbol
kilo	10^3	K
mega	10^6	M
giga	10^9	G
tera	10^{12}	T

KV	kilovolt
KW	kilowatt
MW	megawatt
GW	gigawatt
TW	terawatt
KWh	kilowatt hour
MWh	megawatt hour
GWh	gigawatt hour
TWh	terawatt hour

PART A: THE EVOLVING MILIEU

INTRODUCTION

In this report an attempt is made to synthesize available information concerning the nature of Canadian experience with interbasin diversions. In the first part generalizations are assembled concerning Canadian developments to date, jurisdictional controls over interprovincial diversions, as well as major large-scale changes which could potentially be induced by water transfers which cross continental drainage divides or other major watersheds. Then proposals to export significant volumes of Canadian water are reviewed as well as recent developments in the United States which could condition the likelihood of diversions in that country which could affect the Canadian water resource. Finally, long standing Canadian federal policy to oppose water export is reviewed and potential policy revisions are suggested.

In the second part of the paper, case studies of 5 Canadian diversions are presented: The Ogoki and Long Lake in Ontario, the Kemano in British Columbia, the Churchill-Nelson in Manitoba, and the James Bay in Quebec. These are all hydroelectric projects, with log driving benefits also associated with the Long Lake example. In each case salient facts and lessons are reviewed concerning the nature of the projects, the biophysical, social, and economic changes induced by each, and the institutional management process. An effort is made to evaluate each project in terms of the social values, environmental standards, and approval processes prevailing at the time to avoid being overly critical of the efforts of project proponents, politicians, and government regulators involved.

In the final section, Part C, emerging lessons and policy suggestions are drawn concerning the processes used to approve the Canadian diversions and their effects. Policy suggestions are made to improve the efficiency and social equitability of future projects. Questions of policy and science are raised which require investigation to enable responsible decisions to be reached concerning the desirability, scale, and management of future diversion proposals.

Related literature pertaining to man-made lakes is not reviewed in this report. However, there has been considerable effort devoted to their field (Ackermann et al. 1973; Atton 1975; Baxter 1977; Baxter and Glaude 1980; Dickson 1975; Duthie and Ostrofsky 1975; Efford 1975; Geen 1974; Ruggles and Watt 1975) and the observed impacts and research needs in the area are clearly identified. All of the biophysical, socioeconomic, and political problems encountered when man-made lakes are created are experienced with diversions. But water transfer effects are normally more complex.

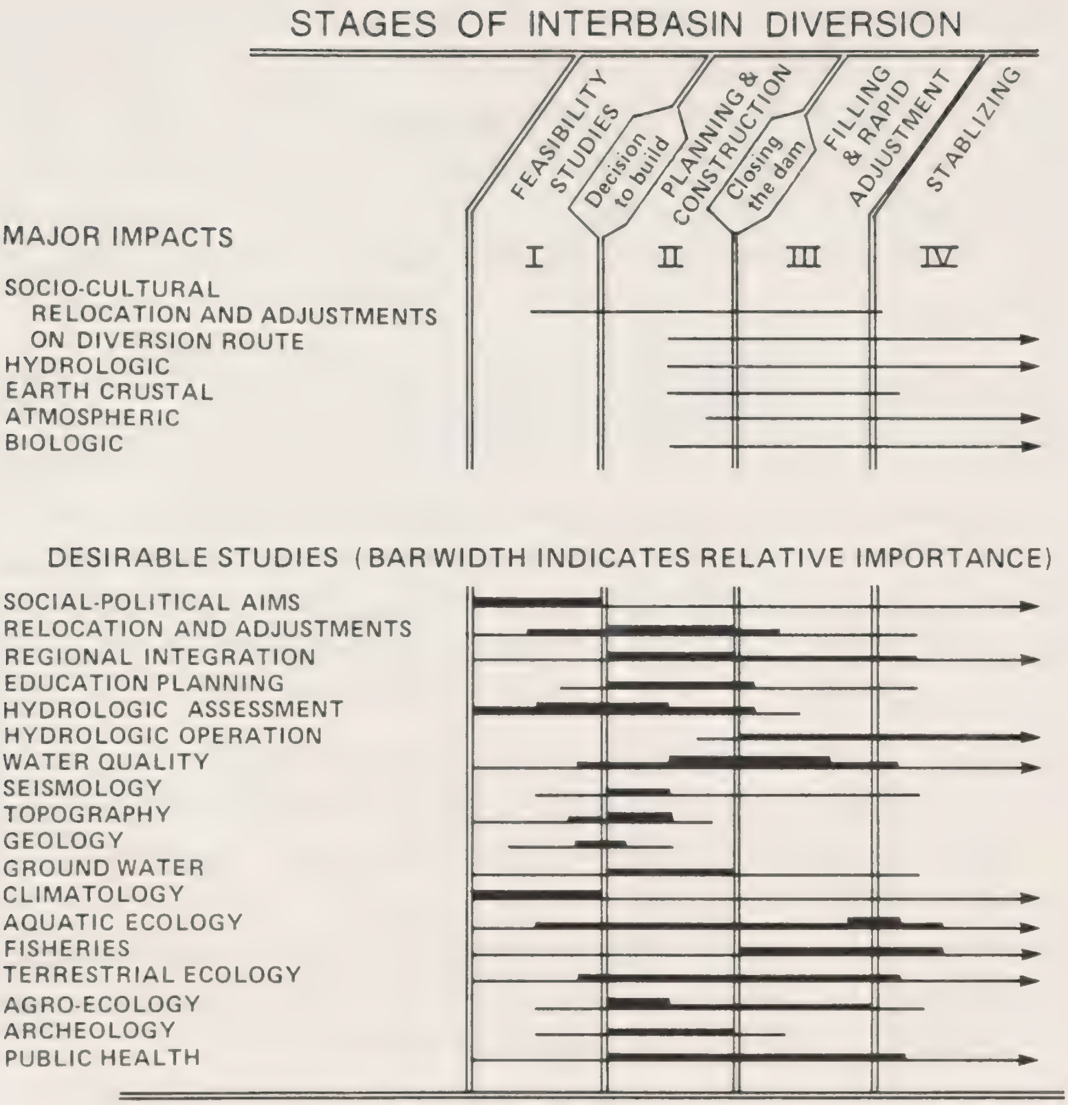
Multiple lakes are frequently formed as part of a diversion, new or enlarged river channels are constructed, water and biota from different watersheds are mixed, and important changes may be induced in regional climates and marine ecosystems hundreds or thousands of miles from the altered environment.

Evaluation Criteria

It is often difficult to reach a judgement concerning the effectiveness of resource management decisions because of lack of information on the decision making criteria used to approve projects, the absence of preproject surveys to establish bench mark conditions prior to disturbance, uncertainty due to natural fluctuations, and the paucity and fugitive nature of postproject monitoring data. These generalizations are especially true for large projects such as interbasin transfers whose effects are widespread, imperfectly monitored, and where responsibility for measuring change is never assigned to a specific agency and almost inevitably confused with federal-provincial questions of jurisdictional responsibility.

The experience in planning, constructing, and operating the Canadian diversion case studies examined in this report is compared to theoretical approaches from the literature to reach judgements on strengths and weakness of these experiences and their results to date.

Construction of an interbasin transfer normally proceeds in four stages (fig. 1). During the period of feasibility studies, the groundwork is laid on whether to divert a river. While many factors which will ultimately affect the efficiency of the investment such as markets and prices over a decade or more for energy, and agricultural products over several decades, or construction costs, are beyond the control of project analysts, many other biophysical and socioeconomic aspects are capable of a degree of analysis and alternative project design. Knowledge generated during this first stage should assist in reaching appropriate decisions concerning: whether or not a project should be constructed; if the decision is to proceed, what alternative designs will maximize benefits and minimize costs, what development timing is appropriate, and what compensation and mitigation actions will be required to ease the adjustment to project-induced change by those directly affected.



Adapted from Ackermann, White, and Worthington 1973:9.

Figure I. Evolution of impacts of an interbasin diversion.

During planning and construction, stage II, studies are underway on most topics of concern. Then when the structures are completed and the diversion becomes operational, stage III, the new water flow pattern begins to form as new lakes fill and water is redirected through new channels. This creates an intense period of biophysical disruption and cultural stress. Scientific studies at this stage assist in project management decisions to maximize benefits and minimize negative effects (Holling 1978). Finally, after the new system reaches operating conditions and the period of rapid adjustment subsides, components of the diverted systems slowly evolve to a new dynamic equilibrium during the remainder of their operating lives (Ackermann, White, and Worthington 1973: 3-40).

In an effort to understand the complex systems affected by diversions, the affected environment is considered in four parts. These include effects (1) downstream from the diversion on the donor river from which water is abstracted; (2) in the created reservoir; (3) in the diversion channel which carries water for the first time or more water than normal, and finally; (4) in the receiving water body which receives the diverted water. Modifications may be induced in a river, a lake, an estuary, the ocean, or all of these (Bridger 1978; Canada-Manitoba, Lake Winnipeg, Churchill and Nelson Rivers Study Board 1975; Peet 1978).

Finally a number of principles are useful to judge the adequacy of existing effects to manage diversions (National Research Council 1966; Foster and Sewell 1983: 74-95).

1. Planning efforts should attempt to maintain flexibility of actions for the future by foreclosing as few development options as possible.
2. All available methods for coping with the problem being solved by diversion such as alternatives to supplying more energy, or more water for irrigation, industry, or municipalities, should be given appropriate attention.
3. Scientific studies and professional judgement should be used to predict, to the extent possible, the consequences of each management option.
4. The public should be encouraged to comment on the desirability of development alternatives at several stages in the planning process.
5. Environmental protection should be a major development guide.
6. Management mechanisms used for decision making should be capable of reviewing and reconciling major federal, provincial, and local government and public concerns based on common knowledge, understanding, and shared responsibility.

THE CANADIAN EXPERIENCE

It is estimated that Canada has 9% of the world's fresh renewable water. However, with approximately 90 percent of the national population currently living within 150 miles of the southern border, and 60 percent of the total river discharge towards the north, there are places where and times when water shortages occur in intensively settled areas or when water flow can be beneficially transferred from one river to another. Two strategies are commonly used to increase the availability of the resource. Storage reservoirs are constructed to change the annual pattern of water availability within river basins, and an interbasin or intrabasin water transfer in combination with storage is used to increase the discharge of a receiving river, at the expense of one or more donors to generate hydroelectricity, to enhance the capacity for transportation, or to support economic development based on irrigation or industrial water use. Elsewhere surplus waters are removed from streams to protect against flooding or for dewatering mines or construction sites (Quinn 1981: 65).

Water diversions are relatively easy to construct throughout Canada except through the high western mountain ranges. A legacy of the Pleistocene glacial periods is low divides separating most drainages and abandoned meltwater channels which often provide economical sites for constructing diversion channels.

In this report no attempt is made to distinguish between interbasin and intrabasin diversions. Rather, the following criteria are adopted from Quinn (1983: 128): (1) transferred water does not return to the donor stream within 20 km from the point of abstraction; (2) mean annual transferred flow is at least 0.5 cubic meters per second (m^3/s) or has an annual volume of 16 million m^3. These criteria eliminate small local withdrawals operated by numerous municipalities, power plants, and individual irrigators. Using these limits, 54 transfers were identified in the 9 provinces but none as yet in the northern territories (table 1).

The principal reason for Canadian water transfer has been to generate hydroelectric energy. Quinn explained (1983:129):

> . . . hydropower dominates overwhelmingly in number and scale of transfers with irrigation, flood control, and municipal uses assuming some importance regionally. With almost 70 percent of our electrical energy generated by falling water and 96 percent of our total water transfer attributable to hydroelectric projects, Canada is still very much hydro country.
>
> The total flow involved in water transfer -- 4400 m^3/s -- is significant. If all of this flow were concentrated into a mythical "New River," it would be Canada's third largest, behind only the St. Lawrence and Mackenzie rivers!

> . . . Canadian water transfer is considerably greater than that of the next two countries, the United States and the Soviet Union, combined . . .

Three enormous hydroelectric projects completed in the 1970's which incorporated 5 diversions, cumulatively comprise two-thirds of all the volume of Canadian water transferred to 1980. The Churchill Falls project, completed in 1974 at a cost of $665 million, averaged 37 billion kilowatt hours (KWh) of energy annually using 2 diversions totalling 525 m^3/s over the first nine years of operation (Dawson 1984; Cote 1972). The Lake Winnipeg, Churchill, and Nelson regulation and diversion project, completed in 1977 at a cost of $1.36 billion, produced 75.6% (16.6 million KWh) of the Manitoba energy produced in 1984, partially based on a diverted flow of 775 m^3/s; and phase I of the La Grande project to be completed in 1985 at a cost of $14.6 billion generated 34,300 TWh of energy in 1983, partially based on a diverted flow of 1586 m^3/s. Clearly, water transfers have become a cornerstone of Canadian hydroelectric development policy over the past two decades.

Table I

Canadian Water Transfers Existing or Under Construction: 1980[a]

Province	No. of Transfers	Average Annual* Flows in m^3/s	Major Use
Newfoundland	5	725	Hydro
Nova Scotia	4	18	Hydro
New Brunswick	2	2	Municipal
Quebec	6	1854**	Hydro
Ontario	9	564	Hydro
Manitoba	5	775***	Hydro
Saskatchewan	5	30	Hydro
Alberta	9	67	Irrigation
British Columbia	9	367	Hydro
Canada	54	4400	Hydro

* Estimates subject to revision.

** Excludes Beauharnois Canal flows from St. Lawrence River

*** Excludes floodway flows (Portage Diversion, Winnipeg Floodway, Seine Diversion) of short duration

[a] adapted from Quinn 1983: 128.

Focussing on major diversions only, 17 Canadian diversions each exceeded 25 m^3/s in 1980 (fig. 2, table 2). These mega-scale projects are located in the provinces of British Columbia, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland. The most notable feature of all of these projects is the relative absence of independent critical analysis of what happened as a result of undertaking the work. While it is common to express such effects in terms of kilowatt hours of energy produced or volumes of water delivered, there have been few comparative or even project-specific assessments of the broad range of biophysical, social, and economic changes induced or of the effectiveness of institutional decision-making processes adopted. While some of the evidence currently available will be noted in the case studies which follow, a recent survey of the Canadian published literature by Neumeyer of Environment Canada (forthcoming) indicates that hindsight environmental investigations have not been adequately supported by either governments or proponents. Such work is needed to enable evaluation of the consequences and comparative efficiency of the diverse management strategies and institutional designs adopted to implement diversions to date.

Diversion-related projects will undoubtedly be undertaken in coming decades which will reinforce the established trend across Canada to generate hydroelectricity based partly on diverted waters. These will primarily make use of existing diversions by adding more generating stations in the Labrador Falls area of Labrador, the James Bay basins of Quebec, and the Churchill-Nelson basins in Manitoba. A new diversion to complement the existing Kemano project is also possible in British Columbia. But the prairie situation, and particularly Alberta, differs significantly and is considered separately.

PRAIRIE AND NORTHERN WATERS

Most Saskatchewan-Nelson basin rivers are controlled for hydroelectricity, agriculture, municipal, industrial, and recreation uses. At times some of these rivers cannot meet the demand for water, particularly in the semiarid regions of southern Alberta and Saskatchewan. The problem relates to the pattern of discharge; 60% of the natural flow passes through the region in a 3 month period in spring necessitating massive storage for later use.

Currently, 65% of water withdrawals for offstream uses are for irrigation with uses by municipalities (20%), thermal power (5.5%), industries (7.5%) and tar sands (2.5%) being comparatively lower. Irrigation accounted for 87% of water consumption in the three prairie provinces with 565,800 ha under cultivation in 1980; 85% (482,200 ha) of this was in Alberta. Studies suggest that a further 7 to 8 times this acreage could be

Figure 2. Major water transfers in Canada existing or under construction: 1980. (See table 2 for diversion descriptions)

Table 2

MAJOR INTERBASIN TRANSFERS IN CANADA

EXISTING OR UNDER CONSTRUCTION: 1980[a]

No.	Province	Project	Contributing Basin(s)	Receiving Basin	Average Annual Transfer (m/s)*	Uses	Operational Date	Owner
1.	B. C.	Kemano	Nechako (Fraser)	Kemano	102	Hydro	1952	Alcan Ltd.
2.	B. C.		Bridge	Seton Lake	92	Hydro	(1934)1959	B.C. Hydro
3.	B. C.		Cheakamus	Squamish	37	Hydro	1957	B.C. Hydro
4.	B. C.		Coquitlam Lake	Buntzen Lake	28	Hydro	(1902) 1912	B.C. Hydro
5.	Sask.		Tazin Lake	Charlot (L.Athabasca)	25	Hydro	1958	Eldorado Nuclear
6.	Man.	Churchill Diversion	Churchill (Southern Indian Lake)	Rat-Burntwood (Nelson)	752	Hydro	1976	Manitoba Hydro
7.	Ont.		L.St. Joseph (Albany)	Root (Winnipeg)	86	Hydro	1957	Ontario Hydro
8.	Ont.		Ogoki (Albany)	Lake Nipigon(Superior)	120	Hydro	1943	Ontario Hydro
9.	Ont.		Long Lake (Albany)	Lake Superior	38	Hydro/ Logging	1939	Ontario Hydro
10.	Ont.		Little Abitibi(Moose)	Abitibi (Moose)	40	Hydro	1963	Ontario Hydro
11.	Ont.	Welland Canal	Lake Erie	Lake Ontario	250	Hydro/ Navig	1829ff	Govt. of Canada
12.	Que.	James Bay	Eastmain-Opinaca	La Grande	798	Hydro	1980	James Bay Energy Corp.
13.	Que.	James Bay	Caniapiscau	La Grande	771	Hydro	1983	" "
	Que.	James Bay	Frigate	La Grande	31	Hydro	1982	Nfld. & Lab
14.	Nfld.	Churchill Falls	Julian-Unknown	Ashuanipi-		Hydro	1971	Nfld. & Lab
				Smallwood Res.	196	Hydro		
15.	Nfld.	Churchill Falls	Naskaupi, Kanairiktok	Churchill	330	Hydro	1971	" "
16.	Nfld.	Bay d'Espoir	Victoria, White Bear, Grey and Salmon	Northwest Brook (Bay d'Espoir)	185	Hydro	1969	" "

*Estimates subject to revision

[a] adapted from Quinn 1983: 130.

irrigated if water were available. In addition, instream uses such as commercial fishing; sports fishing, recreation, and tourism; subsistence hunting, fishing, and trapping; hydroelectricity; water transportation; and aesthetics do not withdraw water from lakes and rivers but consititute an important class of water services. Evaporation from man-made reservoirs, especially for hydroelectricity, also accounts for considerable water loss.

There is often a direct conflict between consumptive uses, primarily for agriculture, and instream uses such as hydropower production, fisheries, wildlife habitat, and recreation. Most of the economic water resource projects have already been developed in the water-short southern prairie basins. Further supply augmentation in these areas will only be possible with large-scale storage or interbasin transfers (Environment Canada, Western and Northern Region 1984: i).

Serious tensions are created when proposals are made to transfer water from an area of "surplus" to another of "greater need", or where the water can be applied to a "higher social use." In the southern prairies, offstream withdrawal uses for irrigation, municipalities, industry, and thermal electricity are dominant whereas in north-flowing rivers which would serve as donor sources if southern stream discharge were augmented, transportation, potential hydroelectric power, some resource development, and subsistence needs are most important. They rely on dependable annual flow through the system (Canada West Foundation 1982: XIX-XXXV).

The Northwest Territories Water Board (1984: 1) has countered the common southern perception of surplus northern Canadian waters:

> The Northwest Territories contains approximately 30% of Canada's fresh water resources. At the present time, these northern waters are largely unspoiled by pollution or by physical alteration. There is, however, a general misconception that a tremendous surplus of water exists in the north. Some see northward-flowing waters as "wasting their way to the sea". This utilitarian supply-demand view is seriously flawed in that it does not consider the real value of the north's water resources to northern residents, to the northern environment, and to Canada in general.
>
> While the quantity of water in the north is large in comparison to the size of population and to the current cash economy, certain factors which govern that resource are often overlooked. For example, the traditional uses of water by native peoples, and the inherent values of certain undisturbed northern environments are important in and of themselves. Further, much of the north's ground water is in a permanently-frozen state which denies access and imposes special limitations on engineering and other works. Finally, it must be

remembered that the north is an arctic desert with very low precipitation so that many communities have serious problems obtaining a dependable supply of good-quality fresh water.

The Saskatchewan-Nelson Basin Board studied the feasibility and cost of storage and diversion works through the basin in 1972. The most promising project configurations explored included 8 new reservoirs, numerous transfers within the basin, and transfers up to 1000 m^3/s from the Peace-Athabasca system and up to 400 m^3/s from the Churchill (Saskatchewan-Nelson Basin Board 1972). However, no effort was made to estimate environmental or social consequences of these options. Other alternatives could be considered in future.

Alberta as Exception

Consumptive use of 17% of the annual discharge of the South Saskatchewan basin in Alberta has supported settlement and economic developments in the southern third of that province. However water consumption for irrigation and increasing waste loadings are contributing to inadequate streamflows and poor water quality. Although Alberta passed an average 83% of the basin flow to Saskatchewan over the past 15 years, 33% more than required by agreement, future development will require hard choices to be made concerning in which tributary and for which uses development will occur--the Red Deer, Bow, or Oldman basins (fig. 3). Agreement on these questions would permit the construction of more storage and intensified management of supplies, uses, and water quality. Subsequently, after the question of water use efficiency within the basin is addressed, especially for agriculture, expansion of Alberta's water use in the South Saskatchewan basin will probably not occur until a transfer is made into the basin (Alberta 1984: 2-3). However, up to the present time, all efforts have focussed on new water supplies rather than giving balanced treatment to both demand management as well as obtaining more water.

Currently 9 of 12 identified provincial water transfers are located in the Bow and Oldman basins; 7 are for irrigation. In 1979 the provincial cabinet established a committee to study the feasibility of interregional water transfer (Laycock 1979). This generated considerable debate concerning the merits of diversions from the Peace and Athabasca into the Saskatchewan basin. Although the Chairman of the Alberta Water Resources Commission, Henry Kroeger, recently stated that such a transfer will not occur in the forseeable future, he did not rule out the possibility in the longer term (Canadian Press, 10 Nov. 1984).

Figure 3. South Saskatchewan River Basin, Alberta.[a]
[a] From Alberta 1984

JURISDICTION

The Constitution Act (Canada 1982) provides for the distribution of legislative powers between the federal and provincial governments and is the basis for the allocation of water management responsibilities in Canada. Although water is not mentioned in the act, the federal government has exclusive jurisdiction over navigation and fisheries (Section 91), shares jursidiction with the provinces over agriculture (Section 95), and has legislative responsibilities with regard to interprovincial and international undertakings including negotiation and administration of treaties (Section 132). In addition, the federal government has certain general powers to legislate for "peace, order, and good government" concerning other matters of national importance. Provinces own the water resource within their boundaries except for national parks and other federal lands. Therefore they have the basic authority to manage the resource, authorize developments, licence water users, regulate flows, and levy fees with respect to domestic and industrial water supply, power development, irrigation, recreation, and pollution abatement (Section 92). In effect, the provinces have ownership and legislative power over water which is limited by federal jurisdiction in selected areas (Percy 1983: 115).

The Canadian government's concern with respect to water is to insure, in cooperation with the provinces, that the national water resources are protected and used for the social and economic benefit of Canadians. In addition to the Consitution Act, the major legislative base for the federal government's activities related to a variety of aspects concerning diversions which affect Canadian waters include the Canada Water Act, the Northern Inland Waters Act, the Fisheries Act, the Canadian Shipping Act, the Navigable Water Protection Act, the Department of Environment Act (1970), and the Environmental Contaminants Act, among others. The federal government has a general mandate for conducting research, collecting data, and maintaining inventories relating to surface and subsurface waters, pollutants and contaminants, fisheries and aquatic ecosystems, atmospheric water, and snow and ice. Its specific powers over navigation and shipping, sea coast and inland fisheries, and migratory birds can all potentially be affected by diversions. In federal lands and territories, mainly in northern Canada, the federal government has the sole legislative responsibility for water management and provides for the conservation, development, and utilization of water resources in these areas (Canada, Fisheries and Environment 1978).

International Waters

The legislative bases for federal actions pertaining to international waters, including potential water exports from Canada, relate to the Boundary Waters Treaty and

the International River Improvements Act. Powers granted under this legislation would allow the federal government to insure that any proposed diversions are in the national interest (Canada, Fisheries and Environment 1984). Jurisdictional control over international waters is reviewed by Dr. A. Scott and associates in their paper for the Inquiry on Federal Water Policy, The Economics of Water Export Policy, 1985.

Interprovincial Waters

The law relating to interprovincial waters is poorly defined and appears to be entering an evolutionary period as pressures for more intensive water development grow (Lucas 1983: 36-40; Rueggeberg and Thompson 1984: 28-55). Previously it was widely believed that provinces have sufficient authority to authorize major water projects within their boundaries, even if adverse downstream consequences result, provided that federal powers over water mostly related to fisheries and navigation could be satisfied. Two cases in the past 10 years have challenged this assumption and there is evidence that citizens in downstream provinces may have a right to bring an action related to damage done by diversions or by pollution in an upstream province. In future a province will need to take careful account of its constitutional position before commencing a project which might have a major impact in another province (Percy 1983).

In the absence of legal predictability, interprovincial accords such as the 1969 Master Agreement on Apportionment between the prairie provinces and Canada covering all interprovincial rivers (Canada et al. 1984) are seen as the only short-term means of resolving the uncertainty of developing interprovincial streams. The Canada Water Act of 1970 appears to be a suitable mechanism to create a forum for encouraging a broader perspective on interprovincial river jurisdictional disputes. However it has not been used to resolve these kinds of questions such as the allocation of the Peace River flow between Alberta and British Columbia. The act is not well liked by some provinces because of the unilateral authority given to the minister of environment under Section 5(1) on international, boundary, or interjurisdictional waters. The long term solution to administering interjurisdictional water is a law capable of resolving conflicts among two or more federal or provincial jurisdictions (Rueggeberg and Thompson 1984).

LARGE-SCALE DIVERSION CHANGES

In spite of the comparatively large number of diversions undertaken for a variety of purposes in Canada, there have been few efforts to systematically document the range of effects initiated in one component such as fish at a number of projects, or in a variety of affected biological, physical, and social components within one project. These changes are often experienced at a distance from the construction activities. An exception to

this generalization is the work of Kellerhals et al. (1979) concerning morphological changes induced by 19 Canadian diversions in an effort to enable prediction of channel changes by increased river flows. Recently there has been speculation concerning more distant consequences of diversion on the oceanic environment, biota, and the global climate.

Biotia Transfer

In only a limited number of instances, such as the proposed Garrison Diverson between the Missouri and Hudson Bay watersheds and the proposed McGregor Diversion between the Mackenzie and Pacific Slope drainages, has the potential for detrimental change related to biota transfer been a major factor in evaluating potential diversion projects. The Rawson Academy of Aquatic Science (1984) focussed attention on the potential importance of fish and their parasites as well as plants and micro-organisms deserving a high priority in determining the consequences of future water transfer proposals. When water is transferred between two drainages, organisms of many kinds can often move across breached watersheds in both directions into new environments; the complex set of biological outcomes is extremely difficult to predict. Invading species may be faced with new predators, prey or habitats as well as new reproductive problems or opportunities. The importance of biological change may range from beneficial to catostrophic with explosive increases in certain populations possible such as lamprey in the upper Great Lakes.

The 5 major Canadian oceanic watersheds have important biotic differences. In view of the fact that major transfers have not yet taken place between the Pacific slope basins, the Yukon, Mackenzie, Hudson Bay, St. Lawrence, and Mississippi drainages, with the exception of the Chicago and Caniapiscau diversions, there is a need for careful assessment of the probable chain of events which could be set in motion should water from one major watershed be transferred to another. For example, gizzard shad and rainbow smelt from the Mississippi could detrimentally affect the Hudson Bay drainage and particularly Lake Winnipeg; squawfish and redsided shiner from the Mackenzie Basin could move into Canadian prairie lakes; pike which carry the parasite Triaenophorus crassus could potentially move from the Mackenzie to Pacific slope drainages with the result that fisheries as valuable as west coast salmon could be detrimentally affected. Many other detrimental biota transfers are possible (Rawson Academy 1984: 5-7).

Estuaries are a unique resource providing valuable habitat for many species of fish, wildlife, and waterfowl and desirable locational features for many cultural activities, particularly in British Columbia and other areas where human activities are forced into

these flat areas by topographic constraints. Further research is needed on the physical, chemical, and biological relationships in estuarine areas, on the characteristics of the salt-freshwater interface, and on the potential diversion-induced change in the estuarine ecosystems.

Ocean Environment

A primary factor causing estuaries and continental shelves to be among the most fertile and productive regions on earth is the discharge of terrestrial fresh water runoff (Neu 1982a). These fresh water currents induce the mixing and entrainment of nutrient-rich deep salt water into the surface layer. In Canada, natural annual runoff varies seasonally with high discharge in the spring snowmelt season and low runoff during winter when precipitation is stored. Production and early growth in nearshore and adjacent ocean waters are related to the massive spring influx of fresh water, light, and the associated surge of nutrients into the surface layers. Any modifications that alter the amount or timing of riverine discharge to the sea, for example by storing water for winter release, can alter the physical balance of natural marine coastal processes and affect the local maritime climate (Neu, 1982a: 7). As a result, productive marine fish populations could potentially be negatively affected by reservoirs and diversions.

Neu (1982b: 46-47) believes that measurable temperature changes have already been induced in the Canadian fresh water regime due to large scale river regulation and to the physics and dynamics of the affected coastal regions. He asserts that the natural 4:1 ratio of runoff in Canada between summer and winter has now shifted to 3:2 due to water storage projects. So far, most of these changes have affected the Atlantic and Pacific coastal waters. Rivers flowing northward to the Arctic have not been involved on a major scale with the possible exception of change induced by the Bennett Dam in British Columbia.

Climate

Since preindustrial times of the 1800's, global carbon dioxide ($C0_2$) concentrations have increased over 20% at a steady rate of 3 to 4% per decade. This change is due, in part, to combustion of fossil fuels in the form of oil, gas, and coal. $C0_2$ plays a major role in controlling the thermal balance at the earth's surface by allowing energy from the sun to heat the earth's surface but limits the escape of energy back to space in a process known as the "greenhouse" effect. Current estimates suggest that $C0_2$ levels will almost double preindustrial levels by some time around the middle of the next century, 60 to 80 years from now, profoundly affecting climate and the distribution of fresh water in the world (Bruce 1984). Although destruction of equitorial forests and desertification are also contributing to the $C0_2$ problem, they are not discussed here.

Some contemporary models suggest that a doubling of CO_2 would result in comparatively large winter temperature increases averaging 3° to 4° C over the Great Lakes basin, 2.5° to 3° C over the northern Great Plains, and more than 6° C in the high Arctic. Summer temperature increases would be slightly lower. Concomitantly, precipitation would likely increase slightly in the Great Plains region but not enough to compensate for increased evapatranspiration from crops and much greater evaporation from large water bodies such as the Great Lakes (Bruce 1984).

The consequences of such changes for agriculture and water resources could be profound. In Northern Ontario and the northern Canadian prairies, increased temperatures will make northern areas with good soils capable of growing crops now characteristic of areas several hundred miles further south. Southern Ontario, Northern Michigan, and New York State will climatically resemble the present United States corn belt and require irrigation. In the southern United States Great Plains, and the southern Canadian prairies, droughts will be more frequent and severe (Bruce 1984).

Due to a 3° C average increase in mean monthly temperature and a 6.5% increase in precipitation in the Great Lakes, Bruce (1984) warned that a probable 21% decrease in outflow will occur from increased evaporation loss and decreased runoff from the land. As a result, a $0.75 billion annual loss related to decreased hydroelectricity, shipping revenues, and shoreline values would be experienced. There will be much greater crop growing potential, due to higher temperatures, if greater irrigation demands can be met. Winter energy demands for heating will decrease but summer demand for air conditioning will increase. And more than 80% of basin water consumption will be in the United States. As a result, further diversions from the Great Lakes basin should not be contemplated until a more complete understanding is available concerning the consequence of the greenhouse effect.

Bruce (1984) also asserts that large scale diversions of northward flowing rivers would have climatic effects of significance. Decreased fresh water inflows to the Arctic Ocean would slightly increase the salinity of Arctic waters. This lowers the temperature at which ice forms and adds to the enormous warming predicted over the coming 60 to 80 year period due to the greenhouse effect. While one or two diversions in Canada may not have a profound climatogical effect, the influence of both Canadian and Soviet diversions together could potentially reduce the discharge of fresh water to the Arctic inducing significant global climatic change. Even though all researchers do not agree with the scenario presented, it would be prudent to investigate its validity before any large diversion of northward flowing rivers is undertaken.

CANADIAN WATER EXPORT

Proposed Interbasin Diversions Affecting Canada

In 1959 the Grand Canal concept was formulated by a Canadian, Thomas Kierans. He envisioned a major dike built across James Bay to trap the fresh water from inflowing streams. Initially, 1130 m^3/s would be pumped south from the bay over the 290 m drainage divide into the Great Lakes and later redistributed to areas of need in Canada and the United States at a cost roughly estimated at $100 billion (fig. 4) (Kierans 1980). In a submission to the Inquiry on Federal Water Policy, 25 years after the concept was initially advanced, Kierans continued to be vague concerning the project benefit:cost ratio, who would pay for it, who would buy water and at what price if it were transferred to the Great Lakes, the associated social and biophysical effects of the project, and when it would be needed (Canada 24 Feb. 1984). Indeed, in a recent cursory examination of the cost of delivering water to the irrigated High Plains area of the United States, Kneese (1984: 8) estimated farmers would be willing to pay about 10% of the actual delivery cost assuming water could be abstracted from Lake Superior without payment for the resource.

The Nishnawbe-Aski Nation has taken the Kieran's proposal as a serious threat to its livelihood and existence. On behalf of its 20,000 Cree and Ojibway members in Ontario living in the Severn, Winisk, Attawapiskat, Albany, and Moose basins, the nation requested the Inquiry on Federal Water Policy to insure that Nishnawbe-Aski is able to participate fully in any discussions, negotiations, and planning exercises with respect to policy development and management of the Ontario Arctic watershed. The history of the nation is tied directly to these waters for fishing, trapping, and hunting and they wish to continue their traditional life style in future (Nishnawbe-Aski Nation 1984).

A 1963 United States Supreme Court decision which restricted Colorado River water use in California led to the conceptualization of numerous long-distance water importation schemes which extended as far north as Alaska to bring water to the American southwest. Canadian water would have been involved in many of these. These proposals were all based on reconnaissance engineering assessments which ignored project benefit cost ratios, the economic value of transferred water, social and biophysical impacts, and political realities. Quinn summarized these ideas in 1973 (table 3, fig. 4).

INTERNATIONAL DIVERSION PROPOSALS

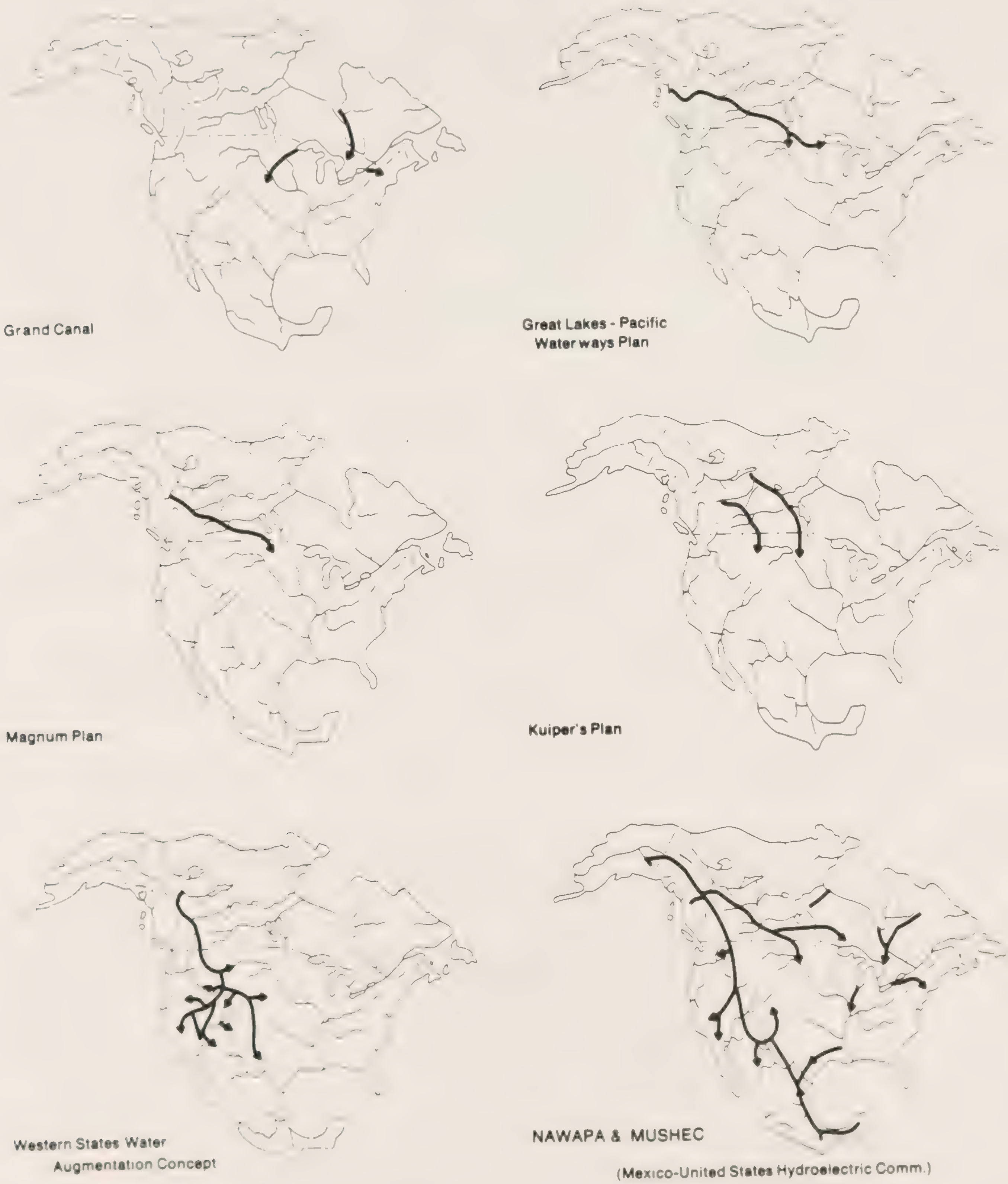


Figure 4. International diversion proposals.[a]

[a] Modified from Quinn 1973

INTERNATIONAL DIVERSION PROPOSALS

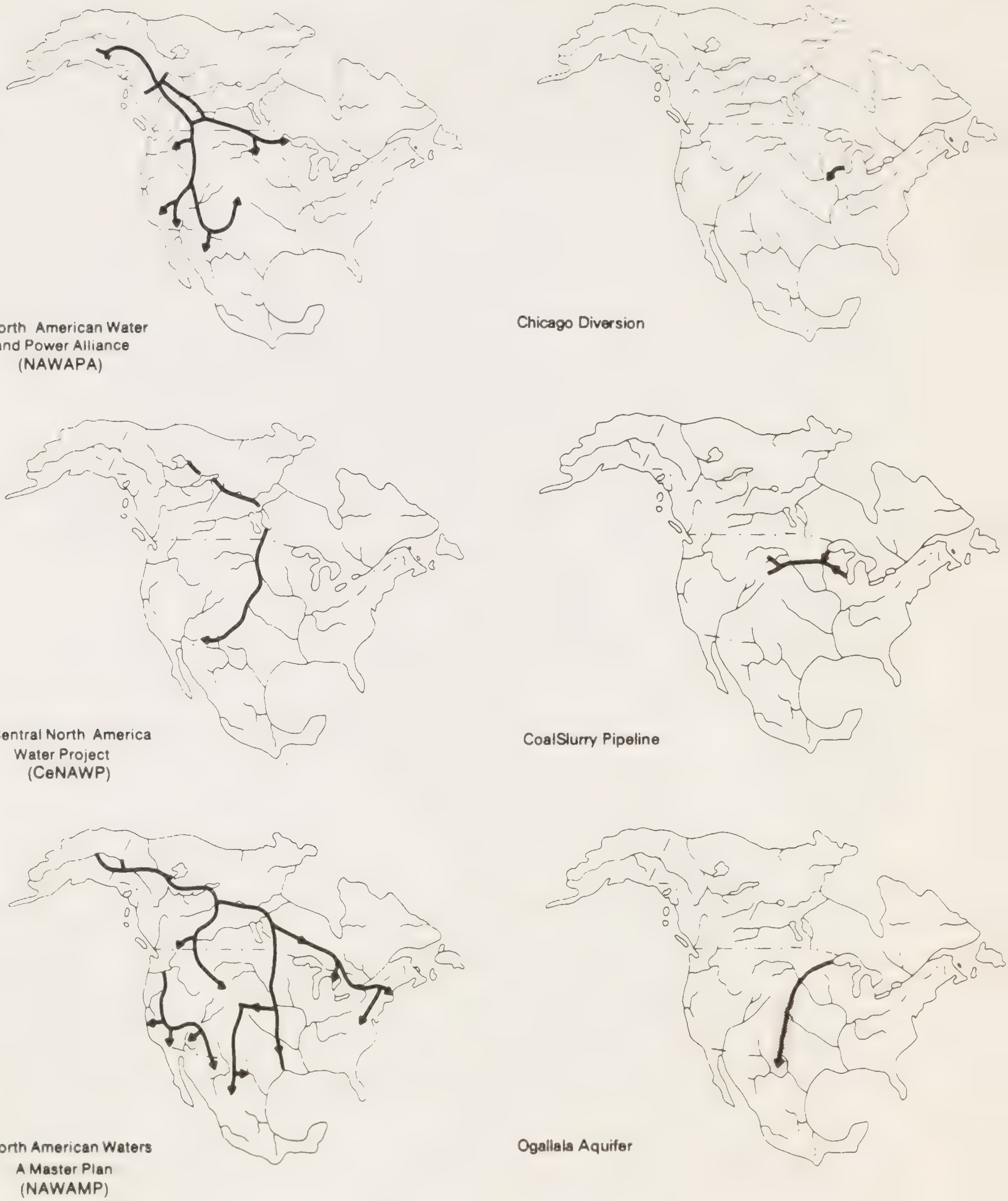


Figure 4. International diversion proposals.[a]

[a] Modified from Quinn 1973

TABLE 3

Proposed Interbasin Diversions from Canada

Proposal (Author)	Year Proposed	Water Source	Annual Diversion (km^3)	Estimated Cost (billions of $)
Grand Canal Plan (Kierans)	1959	James Bay diked, rivers "recycled" to Great Lakes	36	100 (1984)
Great Lakes-Pacific Waterways Plan (Decker)	1963	Skeena, Nechako & Fraser of B.C., Peace, Athabaska, Saskatchewan of Prairie Provinces	142	?
North America Water & Power Alliance (Parsons)	1964	Primarily the Pacific & Arctic drainage of Alaska, Yukon and B.C.; also tributaries of James Bay	136	100
Magnum Plan (Magnusson)	1965	Peace, Athabaska & N. Saskatchewan in Alberta	31 at border	?
Kuiper Plan (Kuiper)	1967	Peace, Athabaska & N. Saskatchewan in Alberta, Nelson & Churchill in Manitoba	185	50
Central North American Water Project or CeNAWP (Tinney)	1967	Mackenzie, Peace, Athabaska, N. Saskatchewan, Nelson & Churchill	185	30-50
Western States Water Augmentation Concept (Smith)	1968	Primarily Liard & Mackenzie drainages	49 at border	90
NAWAPA-MUSHEC or Mexican-United States Hydroelectirc Commission (Parsons)	1968	NAWAPA sources + lower Mississippi & Sierra Madre Oriental Rivers of Southern Mexico	195 + 159 NAWAPA MUSHEC	?
North American Waters, A Master Plan or NAWAMP (Tweed)	1968	Yukon & Mackenzie Rivers, drainage to Hudson Bay	1850	?

[a] Modified from Quinn 1973: 16.

The Ralph M. Parsons Company formulated the most ambitious initiative estimated at \$100 billion in 1964 prices to redistribute 135 km^3 of water throughout North America, to provide 100 MW of energy annually, and to enable cross-continent shipping, the North American Water and Power Alliance (NAWAPA). NAWAPA would carry water south from Alaska, the Yukon, and British Columbia as far as Mexico, to California, the Canadian prairies, the Great Lakes, Labrador, and the American high plains (Parsons n.d.). Several others promoted parts of the NAWAPA concept or completely different schemes in the 1963 to 1968 period (table 3, fig. 4).

The Ogallala Formation

The groundwater resource supplying 6 million irrigated hectares in 6 high plains states from Texas to Nebraska is being steadily depleted by the annual withdrawal of 26 km^3 of water. The area underlain by the Ogallala Formation is of critical agricultural importance as it supplies 40% of the grain fed beef, 25% of the cotton, 38% of grain sorghum, 16% of the wheat, and 15% of the corn in the United States.

One of the many alternative management strategies considered to alleviate this problem is an interbasin diversion from Lake Superior to the Missouri River and two diversions from the Mississippi River to reach the aquifer (fig. 4) (High Plains Associates 1982). In a sequel study, DeCooke and others (1984) reviewed the costs and effects on Great Lakes levels of potential diversions from Lake Superior, Lake Michigan, and Lake Erie to the Ogallala. They report that the cost of two potential diversions from the Great Lakes to compensate for Ogallala diversions from the Missouri and Mississippi would range from \$700 U.S./100 m^3 for a Lake Superior transfer to \$286 U.S./100 m^3 from Lake Erie in 1979 dollars. These costs do not include operations and maintenance nor the economic losses to current Great Lakes users.

Coal Slurry Pipeline

When means of transporting coal from the Powder River Basin in Montana and Wyoming to electrical utilities and large industrial users in the Great Lakes were explored, one alternative considered was a 25 to 36 million ton per year coal slurry pipeline fed by Lake Michigan water (fig. 4) (Wescott 1984). About 30.8 million m^3 of water annually would be needed to transport 36 million tons of coal (Powder River Pipeline Ltd. 1982).

Chicago Diversion

Water has been transferred from the Great Lakes to the Mississippi basin through the Chicago Diversion since the 19th century, at times in excess of 285 m^3/s (fig. 4).

However the flow was limited to 90.6 m^3 by a 1967 Supreme Court decision. As recently as 1980 there were suggestions by United States' interests to increase the Chicago Diversion which would adversely affect power and navigation entities, fish, and wildlife habitat and esthetics in the Great Lakes states and Canada (Wescott 1984).

The Garrison Diversion

Construction of the Garrison Diversion Unit was authorized by the United States Congress in 1965. The purpose of the project was to irrigate 60,700 ha, to provide municipal and industrial water supply to 14 communities, and to provide new recreation and fishing opportunities and wildlife habitat in North Dakota using water diverted from the Missouri River (fig. 5). Since many features of the Garrison Diversion Unit (GDU) are in the Hudson Bay drainage basin, most drainage and waste water from the irrigated areas would flow into transboundary streams and could adversely impact Canada (IJC 1977: 1). This project is the only example of a diversion discussed in this report which would indirectly transfer water into Canada.

Canada has consistently opposed GDU. The basis of the objection is Article IV of the Boundary Waters Treaty of 1909:

> It is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other.

The Canadian drainage systems that would receive GDU waters consist of the Souris, Assiniboine, and Red Rivers and Lakes Manitoba and Winnipeg. Manitoba officials, supported by the federal government, expressed alarm in the late 1960s that leaching of irrigated soils of GDU would degrade water quality throughout the affected Canadian system, but particularly in the Souris basin. It was feared that return flows would increase the amount and frequency of flooding. There was also concern that the water conveyance systems of the Garrison Diversion Unit would provide a direct connection between the Missouri River and the Hudson Bay Drainage Basin thereby enabling the possible introduction of foreign fish, fish eggs, fish parasites, fish diseases, and other biota into Manitoba waters. This could have an irreversible adverse impact on existing aquatic systems, on commercial and recreational fishing in Manitoba, Ontario, Saskatchewan, and Alberta, and on native bands dependent on subsistence fisheries. The project would also cause a major reduction in wildlife habitat in North Dakota (IJC 1977: 1-2; IJC 1978).

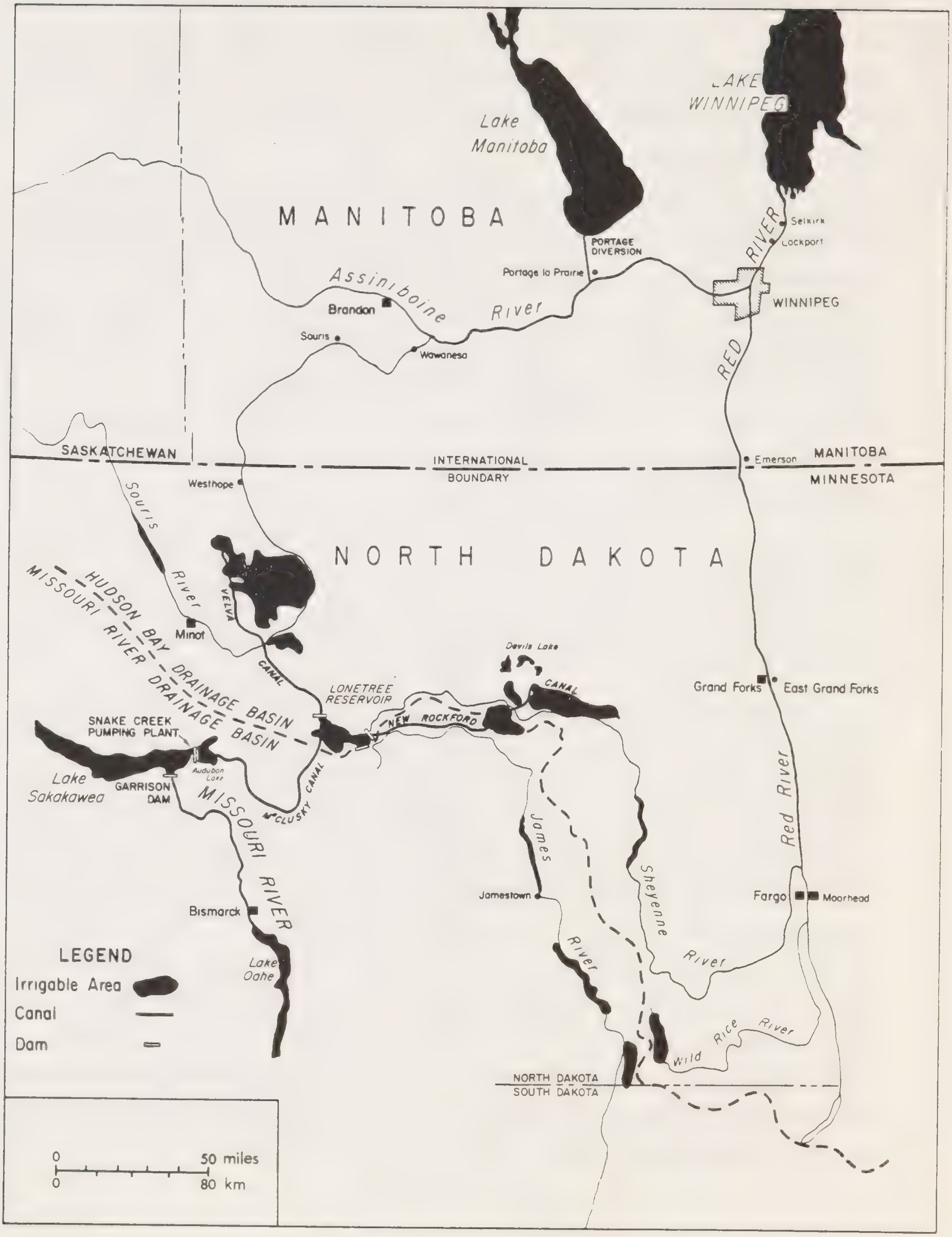


Figure 5. The Garrison Diversion

[a] From International Joint Commission 1977

On 22 October 1975 the governments of Canada and the United States referred to the International Joint Commission (IJC) the matter of transboundary implications of the Garrison project. The IJC submitted its report to the governments in September 1977. Because the GDU could not with certainty prevent the transfer of biota and disease which could cause severe and irreversible damage to the ecosystem, and in particular to the commercial and sport fisheries in Canada, the commission recommended that those portions of the project which could affect waters flowing into Canada not be built at that time.

The United States has continued to respect the IJC finding to the present time that GDU should not negatively influence Canadian interests. A special committee appointed by U.S. Interior Secretary Clark recently recommended against building that part of the project which could potentially adversely affect Canadians. In effect, United States land to be irrigated land would be reduced from 101,000 to 53,000 ha, potable water supply would be expanded from 14 to 130 North Dakota communities, and wildlife and wetland losses would be mitigated on an hectare-by-hectare basis (National Wetlands Newsletter 1985: 5-6).

For nearly 20 years the U.S. Bureau of Reclamation has been trying to implement a massive diversion project, primarily for irrigation benefits. Largely as a result of impartial investigations by the International Joint Commission, full implementation of this project has been delayed until international water transfer, which could detrimentally affect Manitoba interests, is prevented. This is an example of how potential diversions should be analyzed prior to implementation to ensure that negative effects are not experienced by other interests. However, a great deal of time, money, and frustration could have been avoided if the question of biophysical impacts had been investigated and resolved concurrently with the project feasibility and design studies.

The Interstate Water Transfer Threat

The United States Supreme Court has long held that water is not a commodity in commerce and that it belonged to the states. Recently, the court struck down that interpretation by declaring a Nebraska statute that prohibited the export of water to another state as invalid (Sporhase v. Nebraska 1982). In a related opinion the court found that the need of El Paso, Texas for drinking water was sufficient to override a New Mexico law prohibiting the export of groundwater across the border (City of El Paso v. Reynolds 1983). As a result there is now doubt whether state laws, individually or in a multistate compact, could prevent a privately organized diversion of Great Lakes water to meet the needs of a distant region where need could be demonstrated (Durenberger 1984).

Another Supreme court decision raised a different kind of rationale for potential diversion of Great Lakes water. In Commonwealth Edison v. Montana, the court upheld Montana's right to impose a 30% severance tax on coal mined within the state which was used to generate electricity for export to other states. The tax funds were used to keep other Montana state taxes low. If the same kind of tax were imposed on water diverted from the Great Lakes, or from other basins shared by both nations, where a dramatically decreased rate of state taxation was the motivation, there would be little legal protection under laws regulating United States commerce to prevent it (Durenberger 1984).

The Great Lakes Governors acting with Ontario and Quebec were sufficiently concerned about the potential for diversion that they adopted resolutions in 1982 that no future diversions from the basin be considered until a thorough assessment is undertaken involving all jurisdictions contiguous to the lakes concerning the impacts on navigation, power generation, environment, and socioeconomic development throughout the system. In addition, any future decision concerning diversion of Great Lakes water for use outside the basin should only be made with the concurrence of the Great Lakes states, Ontario, Quebec and the two federal governments (State of Michigan et al. 1982). The intent of these resolutions was strengthened the following year by others adopted by the Council of Great Lakes Governors. They agreed to collectively search for institutional mechanism within the United States and jointly with Canada which would enable them to resist or regulate additional diversions from the Great Lakes system (Council of Great Lakes Governors 1983).

CANADIAN WATER EXPORT POLICY

Although Canada has traditionally generated enormous wealth by exporting natural resources such as minerals, oil, fish, furs, and crops with little or no processing, large scale transfers of water have never been sanctioned. In the 1940's, the Right Honourable L.S. St. Laurent publicly raised a fundamental question which continues to preoccupy Canadians. He noted that United States' farming communities coveted unused prairie rivers with some feeling that if Canadians do not see fit to make use of them, Americans should be allowed to do so. He asked (1947):

> Can we, in fairness to Canadian generations of the future, allow such natural wealth to be diverted from our own territory and put to uses from which it would be extrémely difficult afterwards to withdraw it? What is the proper decision to make?

Developments in the 1960's were instrumental in making water a major issue in Canadian-United States resource relations. Following the emergence of proposals advocating the southward diversion of Canadian waters in the 1960's by private sponsors, the Canadian government was called upon to clarify its water export policy. It took a consistent position in Parliament (Hansard 2 Sept. 1964; 28 June 1966; 3 April 1967; 10 Oct. 1968; 24 Feb. and 3 March 1970; 18 Oct. and 12 Dec. 1974) that there were no identifiable markets for Canadian water in the United States and that Canada was not prepared to negotiate water sales in any event because the national supply-demand situation had not yet been adequately assessed. This policy has been maintained by the federal government; to date the federal position has not been refuted by any province.

There have been many recent indications that the long standing Canadian federal government policy which consistently opposed water export needs to be substantiated with research. At the Futures in Water Conference sponsored by the Ontario government in June 1984, Senator Durenberger concluded that "diversions are a very real threat to the future of the Great Lakes" (1984: 11) and the Governor of Utah, Scott M. Matheson (1984: 12), predicted that continental transfers will someday become a reality.

Given this level of certainty and concern related to future United States' interest in Canadian water, detailed studies are needed of current and future patterns of Canadian water supply and demand to determine if a water surplus will exist in specific river basins. This is not an unusual type of appraisal; it is required for sensitive management in any basin where water is used intensively. Careful analysis is also needed of the full range of consequences of rearranging natural flow patterns, of the consequence of the greenhouse effect, and of public attitudes to export before any decisions are made.

It is important to stress that there has never been a request, nor is there currently a request, by the United states to purchase Canadian water. Nor has any reputable study demonstrated an economic justification for water importation. Beginning with President Carter and continuing to the present time, federal subsidies for uneconomic reclamation projects in the United States have been drastically curtailed. Nevertheless, policy can change quickly. It would be prudent for Canadians to be aware of the magnitude of their dependable water resource as well as current and future needs as a basis for making plans for water management provincially and nationally as well as for evaluating export proposals.

PART B: CASE STUDIES
THE LONG LAKE AND OGOKI DIVERSIONS
Historical Development

International agreement was crucial to the timing of development of the Ogoki and Long Lake diversions. The Ontario Hydro-Electric Power Commission determined the feasibility of interbasin water transfers from the Hudson Bay drainage to the Great Lakes for hydroelectric purposes in the 1924 to 1926 period. Canada initially requested that the United States recognize Canadian proprietary rights at Niagara Falls to any water diverted into Lake Superior in 1925. But not until November 1940 did the United States agree to the immediate utilization of an additional 142 m/^{3}/s in Ontario if Canada would rapidly construct the Ogoki and Long Lake diversions (fig. 6). This was to alleviate energy shortages which could hinder industrial production of materiel for the World War II defense effort. The confirmation of Canada's right to the diverted water was made permanent by the 1950 Niagara River Treaty (Peet 1978, 16-26). The emergency nature of the planning and construction for these projects, and the general lack of concern for biophysical and social project effects at that time, meant that these factors were essentially ignored.

The Long Lake Diversion

The Long Lake Diversion transfers James Bay runoff into the Great Lakes. The project, completed in 1939, redirects Kenogami River flows south through Long Lake via an interbasin diversion channel into the Aguasabon River that empties into Lake Superior. To prevent and reverse northward Kenogami River discharges, the Kenogami River Control Dam was constructed 16 km north of Long Lake. At the south end of the lake, a 8.5 km diversion canal was excavated through the height of land. Further downstream the South Regulating Dam was erected to govern southward diversion flows, averaging 42.5 m^3/s, into the Aguasabon River and the Great Lakes. Construction of the Hays Lake Dam impounding the Hays Lake reservoir and the Aguasabon Generating Station was completed near the Aguasabon River mouth in the fall of 1948 (Ontario Hydro Operating Department, 1974). The Kimberly-Clark Terrace Bay pulpmill using the reservoir as a booming ground was also finished in late 1948 (fig. 7). At that time the Long Lake diversion began to perform its present two functions: interbasin pulpwood transportation and power generation locally and in the Niagara and St. Lawrence rivers (Peet 1978).

Figure 6. The Ogoki and Long Lake Diversions

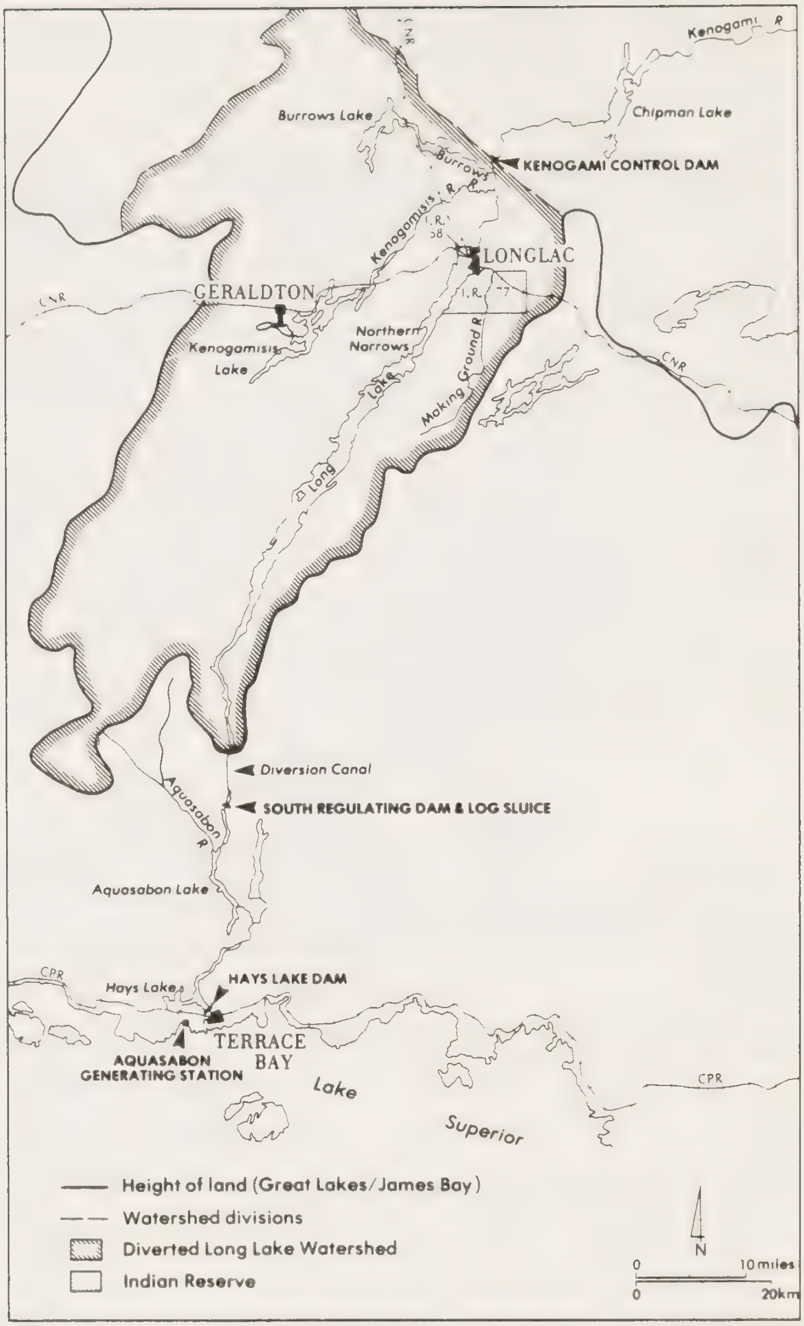


Figure 7. The Long Lake Diversion

The Ogoki Diversion

The project rationale was to divert the northward flowing Ogoki River, a tributary of the Albany, southward through Lake Nipigon into the Great Lakes system providing an average 113.25 m^3/s flow increment for power production at generating stations on the Nipigon, Niagara, and St. Lawrence rivers. The project, which became operational in July 1943, involved construction of a diversion dam at Waboose Rapids (fig. 8) which raised Ogoki River water levels by 12 m, inundating the river valley and the shores of Mojikit Lake up to the height of land. Here, a 0.4 km diversion channel was excavated and the Summit Control Dam constructed to regulate southerly flows. The diverted water augments Little Jackfish River discharges into Ombabika Bay at the north end of Lake Nipigon. Trees were not cleared from the reservoir prior to inundation (Bridger 1978).

An Overview of Diversion Effects

The Ogoki and Long Lake research findings are mainly applicable to small scale Precambrian water transfers which can be achieved without massive ecological disruption or major dislocations or impacts on local inhabitants. Caution should be exercised in transferring Ogoki-Long Lake experiences to large scale diversions such as the James Bay and Churchill-Nelson where more and widespread ecological changes are possible.

Biophysical Change

Diversion-induced erosion is a major concern. In reservoirs, diversion channels, and receiving water bodies erosion has increased turbidity, degraded water quality, impaired habitats for fish, and damaged private property and cultural artifacts. Shoreline erosion continues actively in steeply sloped areas composed of fine glaciofluvial and aeolian deposits in the Ogoki and Aguasabon rivers, 40 years after diversion. The most rapid erosion is experienced in diversion channels. Avoidance or removal of easily erodible soils, armoring or vegetating unstable reaches in these conduits, or the creation of reservoirs where appropriate would ameliorate the problem. Government agencies should be charged with the responsibility of reviewing erosion problems induced by diversions and of ensuring actions are taken to mitigate or compensate those who experience losses within a reasonable period. To enable precise determination of such changes, baseline biophysical and socioeconomic conditions in areas to be affected by diversions should be obtained well in advance of construction to enable appropriate adjustments when problems arise.

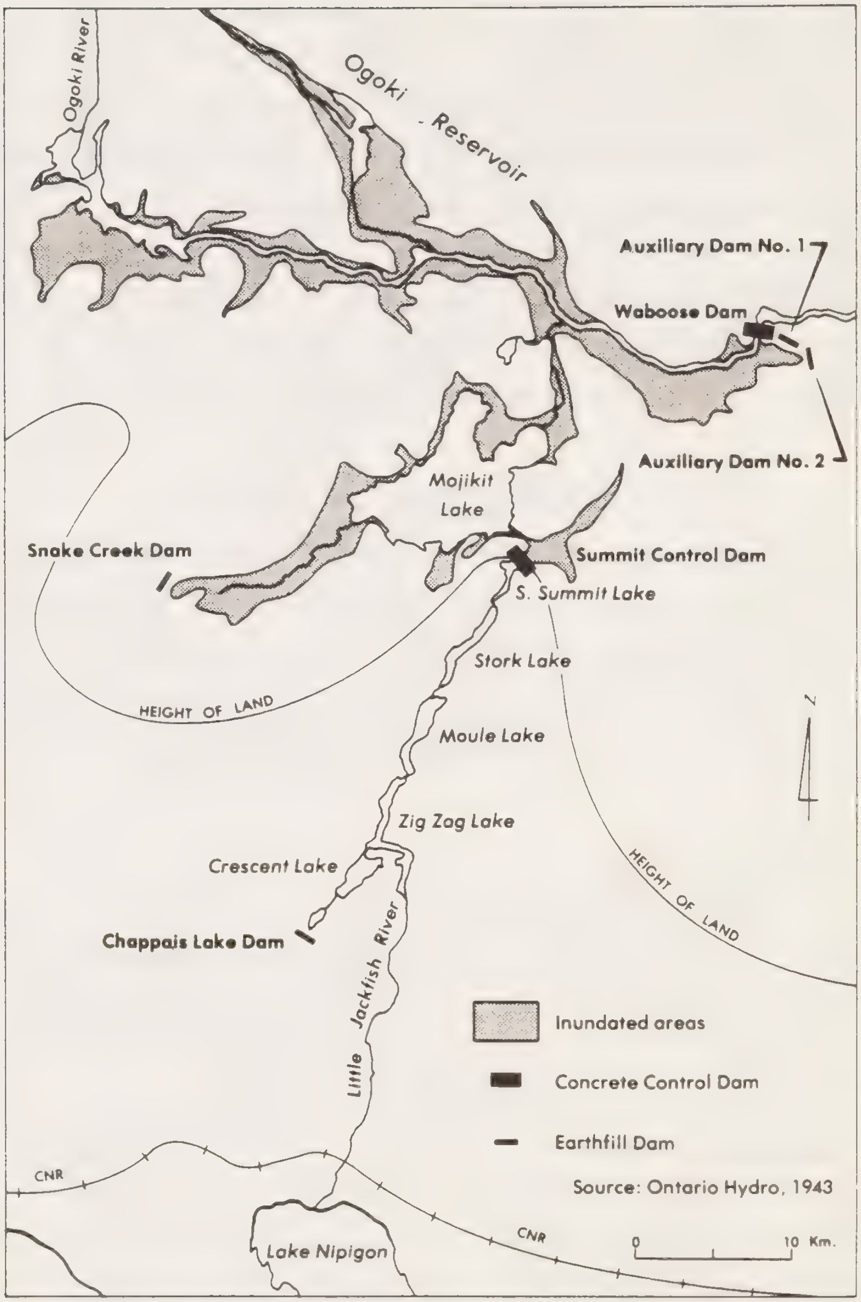


Figure 8. The Ogoki Diversion

Failure to clear trees from reservoirs, diversion channels, and receiving water bodies produces debris which may require hundreds of years to disappear by natural oxidation. Not only is it an economic waste, but floating and beached timber and standing partially submerged trees also cause navigation and shoreline access hazards, and degrade natural esthetic beauty. Additionally, drowned vegetation constitutes a hazard for commercial fishing and a nuisance for sports fishing. On the other hand, since specialized habitats are produced for osprey, eagles, and other species which prefer to nest near water as well as for fish, some trees should be left in strategic ecological locations. Although initial riverine trout habitats are destroyed, the overall impact of drowned vegetation on fish habitats is unclear. Populations of walleye, pike, and moose are abundant in the Ogoki Reservoir and there is no evidence of detrimental effects on caribou and other animals living in the diverted watershed (Bridger 1978).

It is necessary to guard against possible movement of sea lamprey, undesirable exotic fish species, and parasites into new watersheds where they are not present prior to diversion. For example, it was fortuitous that sea lamprey, carp, and other foreign species were not able to enter the Albany River system via the Ogoki or Long Lake diversion systems. This occurred either because Ontario Hydro had constructed power dams prior to the entry of these fish into Lake Superior, or natural obstructions prevented interbasin migration.

Socioeconomic Change

From 1943 to 1974, net economic benefits from hydroelectricity of the Ogoki-Long Lake diversions exceeded \$220 million in 1974 dollars, excluding power benefits accruing to New York and Quebec. Ontario could have achieved even greater financial returns if international and interprovincial agreements with Michigan, New York, and Quebec had been made to reimburse the province for the diverted water which passes through turbines in these jurisdictions on the St. Mary's, Niagara, and St. Lawrence River systems.

Another problem concerns credit for diverted water. Over the 1943-72 period the diversions averaged 160 m^3/s or 18.7 m^3/s (12%) more than originally anticipated. Under the 1950 treaty, Canada presently has had use of only half of this surplus at Niagara, or 9.3 m^3/s. Although the United States agreed in principle on four occasions (1932, 1938, 1940, and 1941) that rights to water diverted into the Great Lakes shall be vested in the country from whose territory it comes, none of these agreements received Senate approval (Friesen, 1981, 203-09). As a result, Canada currently fails to receive credit for about 9.3 m^3/s at Niagara and for all of the diverted water in the St. Mary's and St.

Lawrence rivers because of the failure to establish a comprehensive international Great Lakes Basin water agreement.

A Summary Assessment

1. There is clearly a need to incorporate more socially responsible policies into project operations. For example, it was inequitable to develop and export hydroelectricity from the Ogoki, Nipigon, and Long Lake basins to supply low cost power to users outside the diverted watersheds when residents of the Gull Bay Reserve, Armstrong, and other local settlements in the diverted watersheds must import oil and run diesel generators to produce electricity at much higher costs.
2. Another concern relates to Ontario Hydro northern water rental payments to the Ontario government for water power lease agreements. Some of these funds should be used in the north to ameliorate negative effects of diversions and other resource use problems. Environmental degradation attributable to flooded forests, log driving, reduced fish stocks, and local energy supplies could all be improved by greater capital investments funded from provincial water rental taxes.
3. Compromise in choosing among management alternatives will always be necessary, particularly where specific hydroelectric operational procedures could cause serious or irreparable damage to other resource users. For example, water levels should not be maintained artificially high or low for extended periods if widespread erosion or fish egg mortality results. Bypass facilities could be built around dams to facilitate movement by travellers. And tourist outfitters and other resource users should be notified in advance of major changes in water flow direction and magnitude to permit adjustments in water use plans. All of these problems are reported or alleged in the study areas (Peet 1978).
4. It is difficult to dispute the overall social usefulness of the projects when such enormous economic benefits are compared to the more minor, yet manageable, diversion-created difficulties and inconveniences considered above. Moreover, forestry is the main Long Lake area industry and its development would have been delayed many years without the diversion. The Long Lake Diversion, through the provision of power and a transportation facility, is responsible for the siting, construction, and growth of the Kimberly-Clark pulp mill and the Town of Terrace Bay. The social evolution of the Town of Longlac is also directly related to the Long Lake Diversion for log handling. While some Ogoki-Long Lake resource users are still partially hindered by diversion operations, in most cases ecological or social impacts have moderated or stabilized, and resource users have adapted, or remedial measures have been taken (Day et al. 1982).

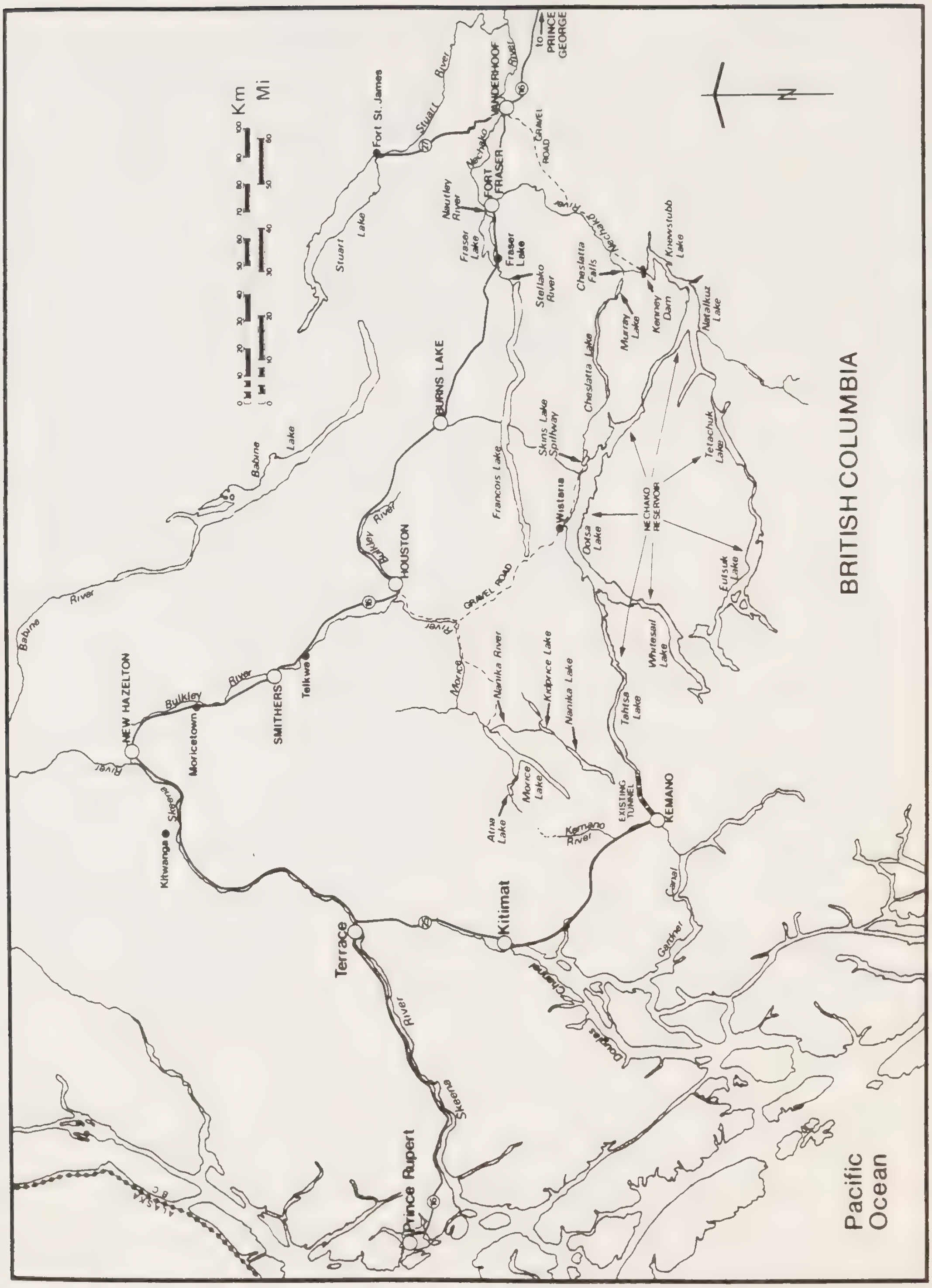
THE KEMANO DIVERSION

Historical Development

In an effort to promote industrialization in its mid-coastal region, The Province of British Columbia invited the Aluminum Company of Canada (Alcan) in 1948 to explore the feasibility of developing hydroelectric capacity as a basis for an aluminum smelting industry. This led to a significantly different type of diversion than the others considered in this report. Instead of using an enormous volume of water and low head, a comparatively small flow falls through a large head to develop electricity; and instead of creating economic development and jobs in other parts of the province, the Kemano project led to the establishment of a stable multinational company, modern communities, and it attracted new industries to an undeveloped region of the province.

The provincial government gave Alcan a variety of incentives to develop at Kemano in view of the fact that there was no public money in the venture. A conditional water licence granted in 1950 authorized Alcan to store and divert the remote and unrecorded waters of the Nechako River above the Grand Canyon, Skins Lake, the Nanika River from 2 miles below Kidprice Lake, and to divert up to 269 m^3/s (fig. 9). Approximately 77,000 ha of land were authorized for occupation. Land needed for the project was sold to the company at minimum provincial prices. Timber on this land could be destroyed, damaged, or removed without stumpage or royalty fees. The 334 km^2 of flooded lands were protected against staking for minerals, petroleum, and gas. Annual water rental fees were based on horsepower year units at 1.66 times the average price per pound of aluminum produced and fees for flooded crown land were set at 0.66 times the average annual price of aluminum produced per acre flooded. The company was required to clear to low water level all public road and trail ends and water trails between lakes at a cost not exceeding $250,000, and to restore public facilities in use at that time. Municipalities were created for the associated settlements at Kitimat and Kemano and industrial townships, designated and owned by Alcan, were created to embrace all of the company's project works.

Power and flooding taxes, and expenditures for engineering design work, were paid by Alcan in lieu of other provincial taxes on the project property or on electricity generated. Alcan was required to pay taxes on land and improvements outside of the industrial townships or organized municipalities, municipal property, land and school taxes on company land within an industrial township, and other normal provincial taxes for corporations. However, the company could not be compelled to sell power to other interests (British Columbia, Department of Lands and Forests 1950).



Source: after Aluminum Company of Canada Ltd.

Figure 9. The Kemano Diversion

The Alcan project, based on the Kemano Diversion, was the largest corporate project undertaken in Canada when it was completed in 1954. The \$500 million investment would cost an equivalent of \$2 billion in the mid-1980's. The Nechako River flow from a 14,000 km^2 watershed was stopped by the Kenny Dam in October 1952 to create a 900 km^2 reservoir which extends 160 km to the west end of Tahtsa Lake. A spillway at Skins Lake, on the north side of Ootsa Lake, is used to control the reservoir elevation. From the west end of the reservoir, a 16-km tunnel transports water through the mountains and provides a 792 m drop to the 896 MW Kemano powerhouse, nearly 16 times the height of Niagara Falls (Alcan Smelters n.d.). A 115 m^3/s average flow applied to the 635 MW average load produces roughly 5.5 GWh of energy annually (Rich 1985). Water from the power plant is discharged to the Kemano River and ultimately to Douglas Channel in the Pacific Ocean. Energy from Kemano is transported over rugged mountainous terrain 75 km northwest to the Kitimat aluminum smelter.

Two townsites were created as part of the project. The remote Village of Kemano at the hydroelectric plant houses a community of 250; aluminum is produced at the Kitimat deep ocean port, 700 km north of Vancouver, where the population grew to 13,700 by 1982 (Goodman 1982).

Biophysical Change

A number of factors contributed to the insensitivity with which environmental factors were handled in the licencing, planning, construction, and operation of the initial Kemano Diversion. Most importantly, such projects were basically approved by the provincial comptroller of water rights; multiple-use river basin management was not a widely accepted resource management strategy at the time. Rather, the project proposal was perceived as a problem in engineering design, construction, and physical availability of water. All other matters were secondary. Secondly, neither the federal Department of Fisheries nor their provincial counterparts insisted on the protection of fisheries which would be negatively affected. There was even less interest in the forests to be inundated or potential erosion to be induced by the final project design.

Fish

Although the Province of British Columbia surrended all rights over the unrecorded waters of the Futsuk and Tahtsa basins within the project area, this did not compromise federal powers to protect the Fraser River salmon stocks under the Fisheries Act. The federal Department of Fisheries submission to the provincial water comptroller requested that no licences be granted for the Kemano Diversion until Alcan and the department had the opportunity to investigate the fisheries, exchange data, and protect

the stocks which could be negatively affected. However the fisheries department did not insist on fisheries protection; they assumed that equitable arrangements could be achieved by negotiating with Alcan.

In granting a conditional water licence to Alcan, no provision was made by British Columbia to protect the fisheries stocks by insuring minimum flows. Indeed, even before the project plans had been developed, the provincial water comptroller decided that the project could be developed with comparatively small interference with the fishery industry (Farrow 1949). Studies conducted by the federal Department of Fisheries and the International Pacific Salmon Fisheries Commission from 1951 to 1953 led to recommendations that adequate flows for fish transportation, spawning, and rearing be provided for the Nechako River salmon populations and to maintain a near normal temperature regime, downstream from the Kenny Dam. Due to the topography, historically salmon were unable to migrate upstream of the Kenny Dam or up the Cheslatta River (Mayhew 1951).

The federal Minister of Fisheries made conciliatory proposals to Alcan to achieve these objectives. He requested the assurance of a minimum of 45 million m^3 of cold-water releases annually as required for migration transportation water, winter cover water, and Nechako River channelization to allow efficient use of the reduced flow.

Alcan decided that deep water cooling releases from the Kenny Dam were not necessary to protect salmon downstream. Instead, a spillway was installed at Skins Lake and a dam on Murray Lake, immediately downstream from the outlet of Cheslatta Lake, to provide water for fish which was much warmer than deep reservoir releases.

During the period of reservoir filling from October 1952 to June 1955, no water was released from the reservoir to the Nechako River and only intermittent releases were made between June 1955 and January 1957 (Canada and International Pacific Salmon Fisheries Commission 1979; 3-4; 1952: 39 and 42; 1951: A and B).

Before the diversion, flows over the chinook salmon spawning grounds normally ranged between 110 and 200 m^3/s during spawning; after installation of a temporary storage dam on the Cheslatta River to protect the fish, the spawning period flows were reduced to approximately 17 m^3/s until the end of 1956. As a result, much of the spawning area was exposed and the situation persisted until a continuous discharge from the Skins Lake spillway began in January 1957. The combined factors of spawning bed dewatering, increased siltation, and increased temperatures from the Skins-Cheslatta lakes system as well as unknown escapement changes contributed to the decimation of

the Nechako chinook salmon stock. Since 1957, when water became available again, the stocks recovered to 40% of their pre-diversion levels (Canada and International Pacific Fisheries Salmon Fisheries Commission 1979: 3-4; Canada 1984: 1).

The Kemano River supports all five species of Pacific salmon and a major eulachon population. It is hypothesized that dramatic increases in the average pink and chum salmon runs since the diversion are a result of improved spawning and incubation environment changes due to the increased discharge from the Kemano hydroelectric plant (Canada, Fisheries and Oceans 1984: 41-46).

For more than 20 years following initial operation of the Alcan smelter there was adequate water for both energy production at Kemano and fish in the Nechako River below the Cheslatta confluence. But in November 1979, Alcan reduced the monthly flow to 63.1 m^3/s, from the previous 22-year average of 432.6 m^3/s, and proposed to maintain this level throughout the 1980 sockeye migration period (Canada and International Pacific Salmon Fisheries Commission 1983: 3). When Alcan refused a request by the federal minister of fisheries to increase the discharge to protect fish stocks based on its opposition to any limitation to impound and divert water under its longstanding licence, the federal government obtained a mandatory injunction in the Supreme Court of British Columbia. It ordered Alcan to provide 225.5 m^3/s below Cheslatta Falls until 20 August 1980, 31 m^3/s from 21 August until 30 March 1981, and 56.6 m^3/s from 1 March to 30 June 1981 (British Columbia, Supreme Court 1980). These orders were later made permanent.

The problem of biological accommulation of mercury in inundated areas was unknown in the scientific literature in the 1950's. Surveys were not undertaken to check fish for this problem.

Erosion

Natural flow through the Skins Lake-Cheslatta Lake system was small. When the Skins Lake spillway came into use, discharges as high as 480 m^3/s, many times the natural discharge, were released through the system. One Indian graveyard was lost by erosion in the 1950's. Widespread unconsolidated sediments were eroded and swept through the Cheslatta River and lake despositing silt and debris in chinook spawning grounds of the Nechako River (Canada 1979: 4). Closure of the Nechako Dam also caused major erosion which Alcan corrected 75-km downstream in a tributary, the Nautley.

Tree Clearing

In recent years Alcan has begun to improve the esthetics of the flooded reservoirs. Based on discussions with local residents to establish priorities, $500,000 has

been spent annually clearing drowned trees by cutting them 30-feet below the reservoir surface. Over time, this work will improve the appearance of the reservoirs for recreationists.

Parks

In 1955, the Tweedsmuir Park boundary was modified because 80,000 ha was to be flooded by the Kenny Dam. The northern end of the park was reduced by 400,000 ha in 1955 to accommodate the Kemano Diversion although 50,000 ha was added at the south end of the park the following year. As a result of this change, a scenic 400-km circle waterway composed of small-to-large lakes and short-to-medium river reaches was lost. Alcan made no significant contribution to the Parks Branch to compensate for these changes although over the years the company has removed some snags and drowned trees to improve boating safety and esthetics (Velay 1985).

Social Change

Reservoir and Spillway Residents

When Alcan suddenly decided in 1952 to reduce the development time for Kemano construction from 5 to 3 years so that aluminum could be made available for the Korean war effort, a variety of concerns emerged rapidly. One of the most serious was the decision to release water from Ootsa Lake through the Skins Lake Spillway and to provide storage in Murray and Cheslatta lakes for fisheries needs.

There was a sparse population in the flooded area prior to construction of the Kenny Dam. Existing records are imprecise but it appears that the properties of 5 to 10 ranch and farming operators on Ootsa Lake were purchased outright by Alcan (Rich 1985). In addition, there were 10 reserves belonging to the Cheslatta Band. An initial reconnaissance by R. Howe, Indian Superintendent for British Columbia (1951), indicated that the best reserve land, such as natural hay meadows, would be flooded; the remaining unflooded land was considered to be of little use.

Tremendous pressure was placed on the Cheslatta Band members along the spillway route to sell their land rapidly and leave the area. Records indicate that Alcan applied for a licence to flood Murray and Cheslatta lakes on 2 April 1952; 6 days later the Cheslatta Dam was closed and water storage began. In the meantime, the first meeting was held with band members on Cheslatta Lake on 3 April, 3 days before the water began to rise. A settlement was reached less than 3 weeks later, on 21 April, in which the company agreed to erect 2 permanent monuments above the flood line indicating the location of 2 grave yards, to pay compensation to each flooded family, and to assist moving them from the area. Nine families were temporarily evacuated by 2 May 1952.

Then on 21 July 1952, a water licence retroactive to 2 April was issued to Alcan by the B.C. Comptroller of Water Rights permitting the company to flood the Cheslatta Lake, 4 months after the water started rising. Finally, on 14 October, the federal superintendent of Reserves and Trusts reported that the minister of Indian Affairs had approved the sale of the Cheslatta band land to Alcan, 7 months following the sale (Canada 1985). Alcan paid $125,500, the outstanding balance on the $129,000 price for 10 reserves and one nonreserve parcel on 3 November (Aluminum Company of Canada, Ltd. 3 Nov. 1952).

More than 30 years after these events, the displaced families are considering legal action to regain the losses they suffered and for the way in which they were handled by Alcan and the federal Department of Indian Affairs during the construction of the diversion. In the words of the Carrier Sekani Tribal Council (1985):

> The Indians of Cheslatta were never given an opportunity to discuss the merits of the Murray Lake Dam. They were told about the dam after it had been built and after the flooding had already begun. The people of Cheslatta received meager sums of money in compensation for their losses, all of which was required to buy land to resettle. Most of the people were forced to live in tents between April and November, 1952, before DIA (The Department of Indian Affairs) finally found property for them.
>
> They were forced to build a new life in a farming community with which they had little in common. Many were forced to abandon their traditional occupations of hunting, trapping and fishing. A once proud people had for a time lost all dignity and succumbed to despair and alcohol. Whereas no Indians living at Cheslatta had been reliant on social assistance, now Band members have very few other sources of income.

The Indigenous Kitimat Community

The Kitimat Band was a substantial community of 400 in 1950 when construction of the town and smelter began. In the following 35 years the community grew rapidly and currently numbers near 1000. A large number of band members work in the smelter and relations with Alcan are considered good (Rich 1985). However, as in virtually every other native community, rapid industrialization created tensions as the community adjusted to a new wage economy life style which is no longer based exclusively on hunting, fishing, and trapping.

The New Communities

Over a 30-year period Alcan gained a reputation as a stable employer of more than 2400 people in Kemano, Kitimat, and Terrace. There has only been one legal strike during this period and hourly workers have not been laid off since 1961 when a water blockage to the power plant occurred (Rezac 1985).

Recently, Alcan adopted new recruiting practices to obtain a more skilled and stable work force. More local people and more married workers with families are being hired. A great deal of effort and money is devoted to employee training and apprenticeship programs, improved working conditions, competitive wage and benefit packages, and fitness and recreational programs to enhance the attractiveness of Kitimat and Alcan as places to live and work (Rezac 1985).

Kimitat was structured almost from the beginning to function as a separate municipality with its own elected officials. This has been effective in promoting the notion of an independent town, although Alcan contributes many extra services to support sports, education, and cultural groups. The same approach was not followed at the smaller Kemano townsite. There is some dissatisfaction with Alcan's perceived dominance of community affairs in Kemano and the company is attempting to overcome this problem (Rezac 1985).

Economic Effects

The construction of the first phase of the Kemano project, the provision of good transportation to the area by road, rail, air, and sea, a secure tax base, and an attractive town site have attracted new industry to the area. A new methanol plant employing 80 to 100 located in Kitimat in 1982, a new forest products industry in 1981, and a diverse array of service industries are represented (Goodman 1982). In 1984, the Aluminum Company of Canada Kitimat works employed 2400 and the total payroll was $98.4 million. In addition, Alcan paid $11.6 million in business, school, and municipal taxes. The company purchased $55.4 million of goods and services of which 77% were from British Columbia and 47% from the Kitimat-Terrace industrial area from 246 vendors (Rich 1985).

Alcan supplied hydroelectricity to the central west coast of British Columbia up until 1978 adding a substantial impetus to economic development in the area as company energy replaced diesel generators. In November of that year, the company arranged a 5-year contract to supply 12,000 GWh of energy annually to the B.C. Hydro energy grid which was being extended into the Prince Rupert area. The contract permitted Alcan to sell energy into the provincial grid equivalent to its normal regional demand during this period for 7 to 10 mills/KWh (Zucker 1985).

The Kemano Completion Project

In 1978, Alcan began studies to develop the remaining power facilities contemplated by the original water licence. When Justice Berger of the Supreme Court of British Columbia upheld the right of the federal minister of fisheries to regulate

Nechako River flow to preserve salmon stocks in 1980, Alcan realized that it could not proceed with the development in the same way that the original Kemano Diversion had been built. New economic uses for water had developed in the intervening years and public values had changed; indeed, the initial development plan could have adversely affected many interests. A new management team was appointed and the project was redesigned by a team of up to 28 scientists, engineers, and other professionals at a cost exceeding $20 million over four years (Aluminum Company 1983: ES9; Rich 1985).

A multiple-purpose resource use philosophy was adopted in scaling down the project and an effort was made to make the project compatible with other resource users in the affected area. The principle adopted was to avoid impacts as far as possible through sensitive design and to compensate for residual damages that could not be handled in other ways. For example, an increased municipal tax base could be used to deal with project-related expenses (Rich 1985).

The approach followed in dealing with the public affected, and with potential problems, was to meet with representatives of interest groups to determine the nature of the concerns. Then, company officials talked to individuals in an effort to understand their concerns and to avoid hardships. About 15% of the planning budget was spent on public consultation; up to 10 company employees lived in the affected communities to keep concerned interest groups aware of ongoing studies and to deal directly with affected citizens (Rich 1985).

The proposed redesigned diversion project would cost in excess of $2.2 billion. The original plan to divert all of the Nanika River flow at the Nanika Dam was reduced to 62% of the annual discharge which would decrease the Morice Lake outflow by 25%; the existing partially regulated Nechako River flow would be further diminished by 80%, in total an 88% reduction in pre-Kemano I conditions. As a result, the total diversion to the Kemano powerhouses would be increased by 84% from 110 m^3/s to 202 m^3/s(Canada, Fisheries and Oceans 1984: 13-15 and 37-40). This flow would permit the construction of a 798 MW powerhouse and would allow the construction of 2 new aluminum smelters, the first of which would be located near Vanderhoof. During the construction of the hydroelectric plant and first smelter, 8300 person years of direct employment are anticipated and 5600 person years of indirect work. The new aluminum plant would create 760 direct jobs and a further 930 induced jobs in the province (Alcan 1983: ES 64).

Even though the preparatory studies and public consultation program which Alcan conducted in choosing the recommended project configuration is clearly the most thorough and open prediversion assessment undertaken in Canada to date, the final

decision on approval will not be easy. British Columbia created a "single window" process to review energy projects in 1982 in an effort to simplify project decisions (British Columbia, Department of Energy, Mines and Petroleum Resources 1982). However, tripartitite meetings between Alcan, federal fisheries, and the provincial environment ministry preceeded the establishment of the review process. In spite of early attempts to agree on a sufficient program of research, disagreement exists concerning the most contentious potential project impact, on the fishery. Fisheries and Oceans Canada officials feel the project threatens several species of salmon stocks in the Fraser, Skeena, and Kemano rivers (Canada, Fisheries and Oceans 1984). Other questions raised include the effect of the proposed project on irrigation water supply, cattle fencing, environmental esthetics, domestic and industrial water supply, Indian aboriginal land claims in the Nanika and Morice watersheds, employment instability, and potential negative effects on existing employment in the area (British Columbia, Ministry of energy, Mines and Petroleum Resources 1984). In spite of these potential problem areas, company officials believe that most effects can be mitigated with minor residual compensation; their polls indicate approximately 80% of local residents support for the proposed Kemano Completion Project (Rich 1985).

Due to poor world market conditions in the aluminum industry, Alcan was forced to request the provincial government to suspend the detailed project review in progress in October 1984. The company intends to proceed with the application when markets improve.

A Summary Assessment

1. In an effort to stimulate economic activity in coastal British Columbia, the governments of British Columbia and Canada promoted the establishment of a diversion-based aluminum industry by Alcan in the 1950's. All obstacles which stood in the way of rapid project completion, including the affected native parties, fish, wildlife, forests, and provincial parks received little consideration in evaluating and constructing the original project. Conversely, the proposed Kemano Completion Project has received the most thorough preproject evaluation of all the diversions evaluated in this report.
2. The governments and Alcan were successful in promoting industrialization and settlement of the project area. There was inadequate time in this study to determine if the water and land rental payments by Alcan are socially equitable given the level of taxes paid by the company.
3. The absence of a comprehensive management plan for Pacific coastal fisheries as well as provincial game fish has made it difficult for fisheries agencies to respond

quickly to Alcan's proposals. Fisheries and Oceans Canada has inadequate staff and budgets to survey fisheries habitats and stocks; they rely heavily on company data for their analyses.

4. The project proponent has a right to expect a prompt assessment of development proposals which is compatible with business cycles of 2 to 3 years duration. To insure that development opportunities are not missed, a "single window" approval process such as the one recently instituted in the provincial Ministry of Energy, Mines and Petroleum Resources holds much promise as a mechanism to achieve early agreement on the project evaluation study design, coordinated public hearings, and final evaluations. A great deal of planning and coordination by governments and industry will be needed to produce the necessary studies within such a time frame. Indeed, where biophysical data are not available, a longer period may be necessary.

CHURCHILL RIVER DIVERSION (CRD)

Historical Development

Provincial interest in developing Manitoba's northern rivers for hydroelectricity was first considered in the 1940s. Faced with the choice of developing the hydroelectric potential of its northern rivers or thermal electric generating facilities in the south two decades later, Manitoba chose in 1966 to divert the Churchill and to regulate Lake Winnipeg outflow to meet its annual demand for electricity which is heaviest in winter and considerably less in summer. Manitoba Hydro was licenced to undertake the CRD in 1972, and the diversion was opened in 1976 (fig. 10). The project affected approximately 3875 people on three reserves living along the diversion route: Nelson House (2137), York Landing (453), and Split Lake (1288). An additional 590 nonreserve Indians, largely commercial fishermen and trappers, were affected on Southern Indian Lake as well as a settlement of 14,300 at the City of Thompson (Canada, Department of Indian and Northern Affairs, Manitoba Region 1984: 8). The native parties affected were mainly engaged in seasonal hunting and trapping and the Thompson economy is based on Inco Metals Company nickel mining and refining (Manitoba 1982). When the bands at Cross Lake and Norway House reserves are included on the upper Nelson River, a total of 9000 Cree and 1500 nonstatus Indians and Metis were affected by the diversion and Lake Winnipeg regulation (Keeper 1984). Approximately 213,680 ha were flooded as a result of the Lake Winnipeg, Churchill, and Nelson regulation and diversion project; 4730 ha of these were land of the 5 affected bands (Canada, DIAND 1984: 5). The village at South Indian Lake was partially relocated and rebuilt near the original site.

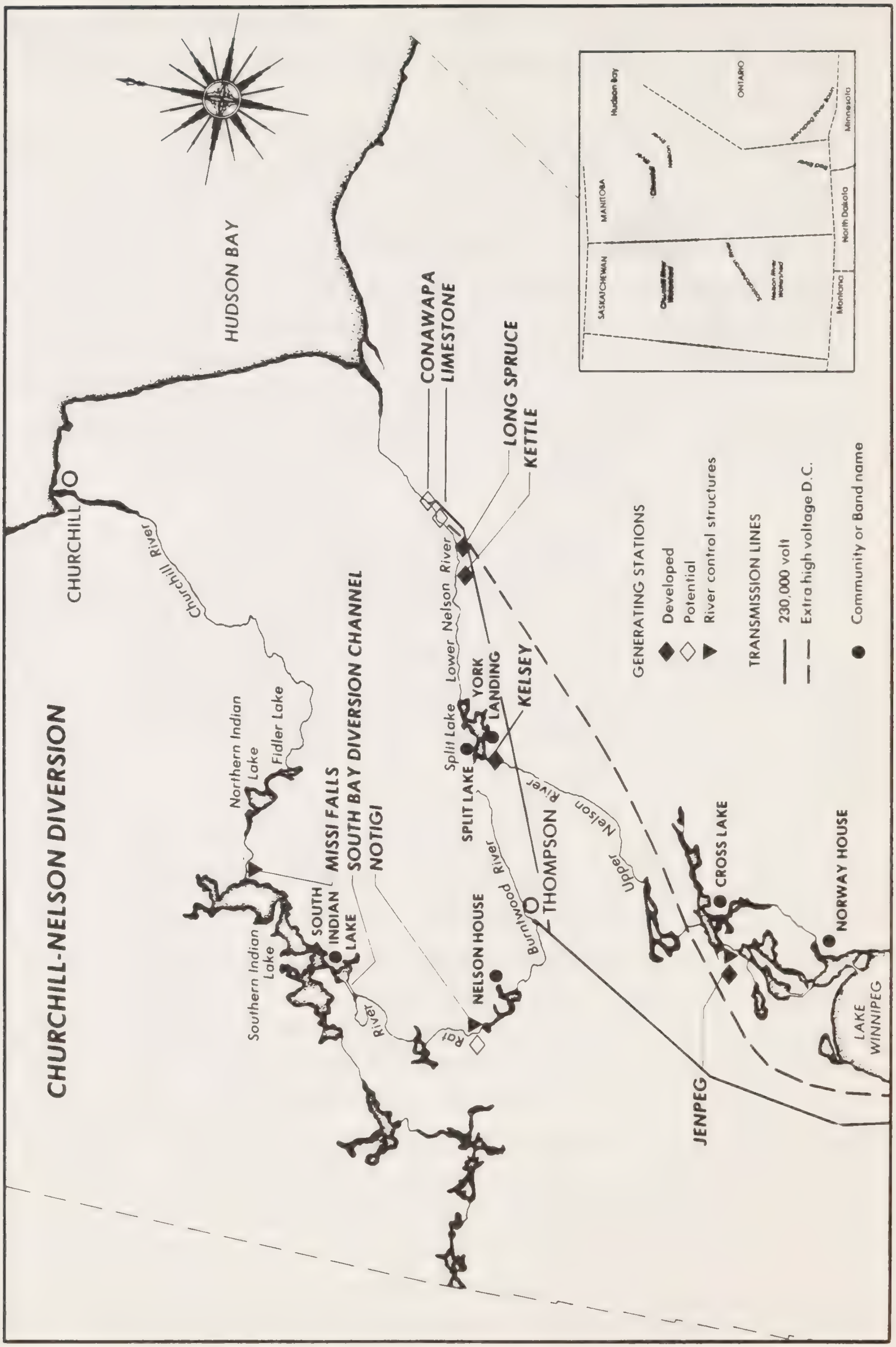


Figure 10. The Churchill-Nelson Diversion

The 250,000 km^2 Churchill River basin extends across the northern half of Alberta, Saskatchewan, and Manitoba. The diversion from Southern Indian Lake (SIL) in the Churchill River has 3 major components. A control dam at Missi Falls, the natural SIL outlet, raised the lake level by 3 meters. A channel excavated from South Bay of SIL to Issett Lake allows an average flow of 775 m^3/s, or approximately 35 times the normal flow of the Rat River and 7 times the flow of the Burntwood River, to be transferred into the 300 km system comprised of the Rat, Burntwood, and Nelson rivers. The Notigi control structure on the Rat regulates flow into the Burntwood-lower Nelson system.

Further south, Lake Winnipeg has a 611,500 km^2 drainage basin with three quarters of its flow derived from two drainages; 42% from the Winnipeg River to the southeast and 33% from the Saskatchewan Basin. The Lake Winnipeg long-term mean outflow is about 2016 m^3/s with winter outflow normally being reduced by 700 m^3/s due to ice blockage. Regulation converted the lake into a reservoir. This was achieved by constructing a control dam and turbines to control discharge at Jenpeg and by dredging three channels to increase the winter flow potential into the river from the lake. When combined with diverted water from the Churchill, ultimately 7000 MW of energy can be produced on the Nelson downstream from Lake Winnipeg (Manitoba Hydro, Public Affairs 1984: 18). Details of the LWR project from Lake Winnipeg downstream to the point of entry of the Burntwood on the Nelson are not discussed here.

Large changes were induced in the water regimes of both the Churchill and Nelson systems as a result of the diversion. Although Manitoba Hydro is continuing to experiment to determine the most economic configuration of diversion flows from the system, the average discharge in the Rat at Notigi has been 807 m^3/s. As a result, the mean annual Churchill River flow at Missi decreased by about 75% from 1011 m^3/s to 251 m^3/s, most of which is supplied during flood peaks. Minimum licensed releases to the lower Churchill are 14.3 m^3/s. At Churchill, the corresponding decrease was about 67% related to a drop in flow from 1131 m^3/s to 371 m^3/s. At the same time, the mean annual flow of the lower Nelson at the Split Lake outlet was predicted to increase approximately 34% from 2265 m^3/s to 3030 m^3/s due to the diversion (Canada-Manitoba 1975: 10-4).

Until 1979, 2252 MW capacity was installed in the lower Nelson River in the Kettle and Long Spruce generating stations at a cost of \$834 million, partially to use water diverted from the Churchill.. An additional \$100 million was invested in the Limestone generation station but this site was temporarily abandoned in 1978 due to a falling rate of energy demand growth (Tritschler 1979: 69, 177, 241). Until March 1984, a total \$1,357 billion had been spent on the Lake Winnipeg, Nelson, and Churchill rivers regulation and diversion project (Canada, DIAND 1984).

A persistent cause of concern in the construction of the project has been cost overruns. When initially announced in 1967, the Churchill Diversion was expected to cost \$20 million (Nelson River Programming Board 965); by 1972, this estimate increased to \$109 million (Manitoba 1972); by March 1984 expenses had reached \$228 and substantial compensation payments to native parties were outstanding. The Lake Winnipeg Regulation project cost including the Jenpeg Generation Station initially estimated in in 1971 at \$105 million grew to \$315 million and the Long Spruce generation station committed in 1972 at a cost of \$448 million was completed at \$505 million (Tritschler 1979: 6). These expenses do not include substantial amounts paid by the federal and Manitoba governments to assist native parties as discussed below.

Power Transmission

Lower Nelson River power is carried to southern Manitoba over two identical 900,000 and 1,000,000 volt direct current transmission lines which are approximately 900 km long. Initial service started in 1971. These were funded by the Government of Canada and will be repaid over a 45-year period. The capital cost exceeded \$200 million. In addition, the Nelson River plants are also served by a 230,000 volt alternating current transmission line. By 1984, Manitoba constructed interties capable of carrying 1500 MW of power to the United States, 150 MW to Ontario, and 375 MW to Saskatchewan. These tie lines will permit the export of surplus energy and increase the security of supply in Manitoba by facilitating imports.

Many interest groups believed that the Churchill River diversion as finally approved in 1972 was based on inadequate planning. Without success, the Manitoba Environmental Council, among others, requested early in 1973 that the project be stopped until proper studies were conducted and all alternatives were fully and publicly examined (Manitoba Environmental Council 1984). Instead, the Canada-Manitoba Lake Winnipeg, Churchill and Nelson Rivers Study Board (1975) was commissioned in 1971 to investigate environmental effects concurrently with project construction which made inevitable the serious Southern Indian Lake permafrost-induced erosion problems; the potential to mitigate this problem by engineering design was foregone.

Biophysical Change

Two environmental impact assessment studies were undertaken in an effort to predict and monitor the effect of impounding, and diverting water from, the Churchill River. Initially in response to public concern, Manitoba Hydro retained a consulting engineering firm to assess the impact of various diversion configurations on natural resource utilization (Underwood-McLellan 1970). Continued public concern led to the

establishment of a federal-provincial study of the scheme selected for construction (Canada-Manitoba, Lake Winnipeg, Churchill and Nelson Rivers Study Board 1975). Subsequently a team of scientists from the Freshwater Institute of the federal Department of Fisheries and Oceans in Winnipeg greatly extended scientific understanding of the biophysical consequences of impounding and diverting riverine lakes in areas of discontinuous permafrost of the Precambrian Shield (Hecky et al. 1984). They conducted detailed monitoring programs over a 10-year period to measure change and determine the accuracy of predictions. However, the Manitoba Environmental Council observed that while considerable attention was paid to the impact of raising the Southern Indian Lake level, virtually none was given to the flooded Rat-Burntwood system or to the dewatering of the Churchill River and estuary, or to the effects of changed water regimes on Hudson Bay (Malley 1984: 3).

Southern Indian Lake

Predicted effects based on the available scientific theory successfully identified the nature of many modifications which occurred in Southern Indian Lake such as increased shoreline erosion, littoral sedimentation, turbidity, and phosphorus availability as well as decreased light penetration, visibility, and light limitation of primary production. However existing theory was inadequate to predict a decrease in the lake water temperature and socially significant changes related to increased mercury content in fish flesh, rapid declines in the quantity and quality of whitefish taken in the commercial fishery, and the need for compensation programs to keep the commercial fishery economically viable (Hecky et al. 1984).

Shore Erosion

There was little experience in the literature to build on when attempts were made early in the 1970's to predict the effects of raising the water of Southern Indian Lake and inundating the surrounding frozen heavy overburden. A schematic cross section with 10-times vertical exaggeration was used to examine the effect of raising the lake up to 35 feet. Although it appeared that erosion-resistant tills and bedrock were close to the surface, and these strata would be encountered after a minor degree of erosion, the cross sections masked the enormous horizontal distance that water would move across the landscape with the 10-foot lake level increase chosen and the potential amount of land which could be exposed to erosion before cohesive layers were encountered. Moreover these studies were commissioned too late to consider another alternative; the dredging of a much deeper channel to permit Southern Indian Lake to remain at about the normal level (Newbury 1985).

As a result of impoundment, the area of Southern Indian Lake increased from 1977 to 2391 km^2, the total volume from 16.84×10^9 to 23.38×10^9 m^3, and the total shoreline length from 3665 to 3788 km. Prior to flooding, 88% of the shoreline was bedrock controlled and only 5% was actively eroding; immediately following inundation, bedrock occurred on only 15% of the shoreline because the post-impoundment water surface intersected permafrost-affected glacial and organic deposits on 85% of the new shorelines. Onshore waves initiated substantial erosion on all shores exposed to more than 1 km of offshore fetch. This has caused retreats of up to 10 m/yr annually removing up to 25 m^3 of material per m of shoreline (Newbury and McCullough 1984). It is not clear, at present, how long it will take to re-establish a stable shoreline around most of Southern Indian Lake. As much as 80% of this eroded material was initially deposited near shore; the remainder went into suspension and significantly increased offshore sediment concentrations by 2 - 5x. This could negatively affect fish reproductive success.

Fisheries

The catch per unit effort of whitefish on the traditional Southern Indian Lake fishing grounds decreased after impoundment. As a result, there was a redistribution of commercial fishing effort and the total whitefish catch was maintained for 5 years after flooding by greatly increased fishing effort and compensation payments; eventually effort declined and total catch declined. The fish quality also decreased due to an increased proportion of darker external fish color and higher cyst counts (Bodaly, Johnson, Fudge, and Clayton 1984). Mercury concentrations in muscle increased soon after inundation in all commercial species. Pike and walleye exceeded the Canadian marketing limit for mercury concentration in flesh and approached the export marketing limit to the United States of 1.0 ug per gram. The rapid increase of mercury in fish is a major problem which must be considered in all future Canadian reservoir proposals (Bodaly et al. 1984).

In 1983-84, Manitoba Hydro signed an agreement with the Southern Indian Lake Commerical Fishermen's Association to provide a $2.5 million one-time settlement for fisheries damages caused by raising the lake and diverting the river. This was intended to restore net income to the prediversion level and to permit fisherman to fly to nearby lakes which were not affected by the diversion (Manitoba Hydro-Electric Board 1984: 14). The funding also permitted the fishermen to purchase smaller nets, boats, and motors for use on the new lakes which are much smaller than SIL. Over the long term, erosion of the lake shoreline should diminish and turbidity should decrease causing mercury levels in fish flesh to fall and commerical fishing in the lake to be restored.

However it is unknown how long these adjustments will take. In the meantime, the Southern Indian Lake community was changed substantially by the diversion as a result of the introduction of the wage economy, increased contact with the south, alcohol, and the disruption of their livelihood.

Other Diversion Areas

Erosion

Four years after the diversion commenced operations, Manitoba Hydro began a field study program in 1981 to document shoreline erosion rates and processes. The study revealed that erosion was initiated by flow change events while periods of stable discharge were normally associated with less erosion. Measured rates varied from a maximum of 7.59 m^3/m of shoreline below the Notigi Control structure to stability. In general, erosion was greatest at sites where surficial materials were exposed to consistently strong turbulent flow or where coarse unconsolidated sediments were exposed in high steep banks. However shoreline materials, wave action, and permafrost all played a role in conditioning the erosion rate at individual sites. Such knowledge of conditioning factors and processes which affect erosion will be useful when further construction work is undertaken and water flow regimes established in the study area in future (Manitoba Hydro, Corporate Planning 1984).

Fish

Few details were known about fish populations prior to the Churchill-Nelson Diversion. The major scientific investigation of the project effects by the federal Freshwater Institute was a broadly based biophysical study focused on Southern Indian Lake; fisheries changes were included in this work. Due to its mandate, the institute was unable to examine management questions which are considered a provincial responsibility. Roughly $2 million were spent on salaries, materials, and supplies for the research between 1974 and 1980, and approximately $130,000 to $150,000 annually since that time for questions related to mercury accumulation. If a new monitoring program is not funded to document diversion efforts, all work will cease in 1985 (Hecky 1985). The Fisheries Branch of the Manitoba Department of Natural Resources which administers the provincial fishery has had inadequate manpower and finances to study the system before the diversion or to systematically monitor its effects. As a result, with the exception of Southern Indian Lake, existing knowledge of effects was derived by reacting to diversion-induced problems throughout the affected system resulting in very limited understanding of induced change. A great deal of potentially useful knowledge was lost by lack of provincial concern.

There was little commercial fishing in the dewatered section of the Churchill River because of the excessive distances to southern markets and sports fishing had not yet developed. Indeed, commercial fishing would not be economic in this area without a transportation subsidy. Lower water levels, increased flow fluctuations, and debris problems made commercial fishing more difficult. Some diversion-induced changes have not yet been explained such as the concentration of high-quality whitefish downstream of Southern Indian Lake at Missi Falls (Hayden 1984); whitefish may have migrated into the lower Churchill and been prevented from returning by the control structure (Bodaly, Johnson et al. 1984).

Downstream of the Churchill Diversion it was predicted that Northern Indian Lake commercial fishery would be eliminated by the diversion. As a result the province converted operations on the lake to a salvage fishery to remove commercial species before they were lost. Fishermen from Ilford permitted to eliminate the stocks encountered higher yields than expected; fish stocks did not fall due to lower than anticipated fishing effort induced by low prices. Conversely, a productive pike fishery on Fidler Lake was destroyed when the lake level dropped severely. Near the mouth of the Churchill, the necessity to relocate the Town of Churchill water supply intake further upstream due to the upstream penetration of the marine salt wedge disturbed an anadromous greyling spawning run on Goose Creek. However, this problem was rectified by Manitoba Hydro (Hayden 1984).

Although few details are available concerning fisheries changes in the Rat and Burntwood diversion route, the short-term effect has been negative. High mercury levels in fish, higher flows, and diversion-related debris have all been detrimental. Nelson House band members traditionally have not fished intensively like their Southern Indian Lake relatives and walleye and pike could withstand heavier exploitation (Manitoba, Department of Natural Resources 1982). As a result, sportsmen in self contained camping units are currently the major users of this area but fishing pressure is light. In future, Issett Lake appears capable of supporting a productive fishery if mercury levels decline (Hayden 1984).

Neither Split nor Stephens lakes in the Nelson River above Kettle Dam have important commercial fisheries at present. Mercury problems in Stephens Lake, a new reservoir, and low grade whitefish are impediments to greater economic activity although increased commercial activity may be possible if mercury levels subside. To date the effect of Kettle Dam on fisheries stocks is unknown. Similarly little is known about the Split Lake stocks. Field studies would be required to answer these questions but funding is not available to do the work.

Approximately 25% of the adult population run of brook trout below the Long Spruce generating station is anadromous. This species is the major stock capable of being affected in this reach. At present this species is overfished from native settlements and by sportsmen outfitters. When the Limestone Dam is constructed, there will be a need to prevent overfishing during the brook trout spawning season in September (Hayden 1984) and to locate roads away from rivers when possible to preserve the fish (Manitoba, Department of Natural Resources 1980, 1981).

Wildlife.

Much wildlife is impacted by changed water levels and flows. For example, as water levels rise, willows could be drowned by flooding and water vegetation destroyed by increasing depth resulting in habitat destruction and the displacement or death of some animals. However, when shorelines restabilize in future, the same vegetation could begin to regenerate in suitable newly created habitats and animals could return to the area. Similarly, reduced water levels in some reaches induce a different set of habitat changes which can both destroy existing habitats and create new ones. Detailed prediversion and postdiversion surveys of habitats and animals thoughout the affected reaches are necessary to document such effects. Such comparative studies were not undertaken in the Churchill-Nelson project area due to the lack of funds.

The major diversion impacts on wildlife should be on species sensitive to winter water-level fluctuations. Both muskrat and beaver may be forced out of their houses in winter to obtain food if water levels fall sufficiently so that their houses become dry, or if water freezes to the bottom of the water body. Fur production records give some indication of the diversion effects. Available data from the fur coordinator, Manitoba Department of Natural Resources (McKay 1984) for the Southern Indian Lake area are ambiguous concerning the changes experienced (fig. 11). The number of beaver taken had begun to decline in the 1972-1973 winter and the catch did not completely recover until 1978; thus the diversion appears to have had little effect on the harvest. Conversely, muskrat numbers appear to have decreased slightly since the diversion became operational in 1977. However, as most trapping is undertaken on tributaries above the flood levels, the reduction of shoreline trapping success is masked.

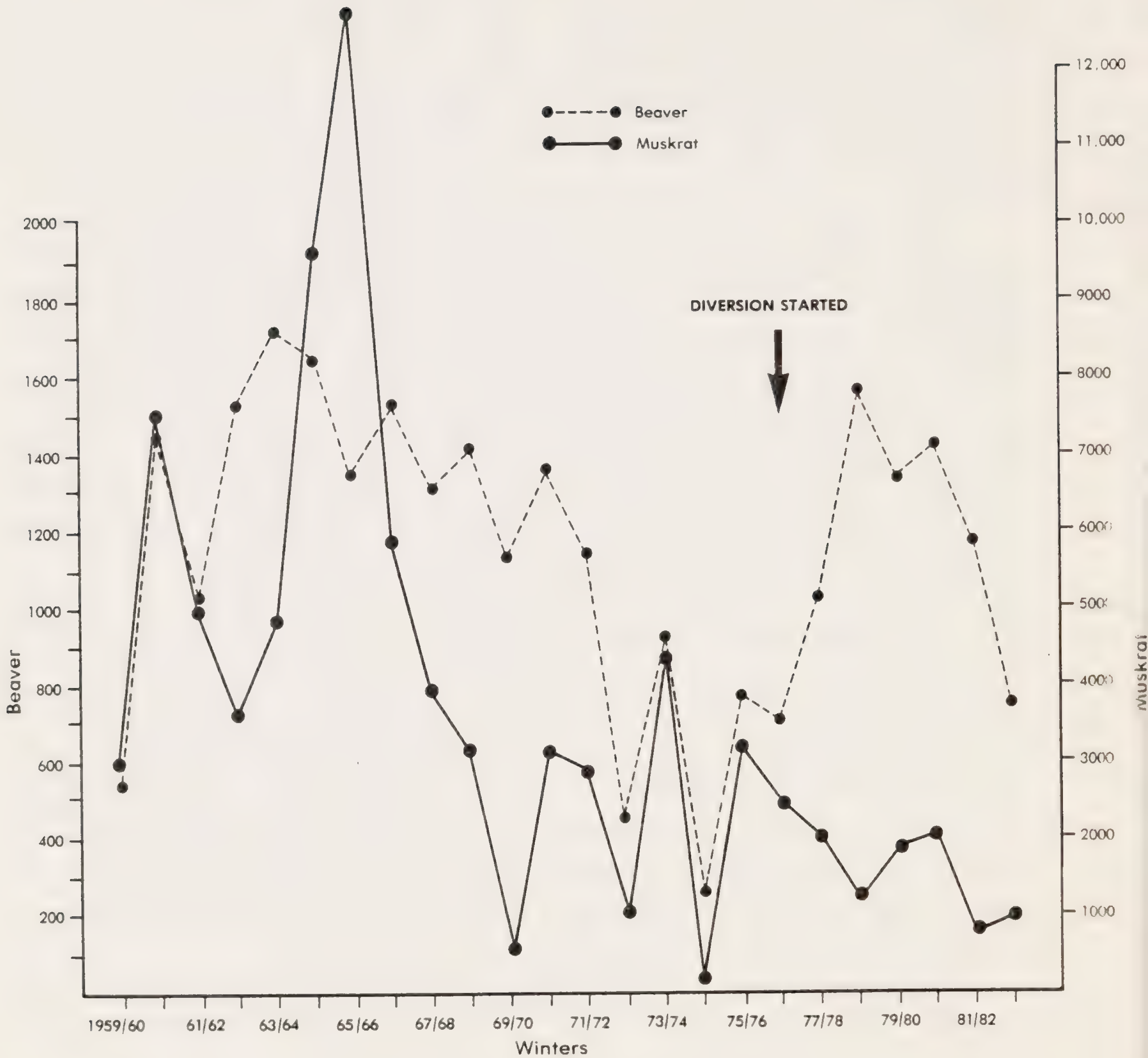


Figure 11. Annual beaver and muskrat production, Southern Indian Lake area, Manitoba: 1959/60 to 1981/82[a].

[a] From Fur Programs, Manitoba Department of Natural Resources

Several factors could influence the observed harvest levels. There could be errors in the production data; natural population cycles could be involved; trappers may have been unable to reach their traplines because of unstable ice conditions created by falling water levels and higher flows during winter; and depressed muskrat prices over the past decade may have resulted in lower trapping effort. In addition, a number of trappers worked on Manitoba Hydro construction projects during this period.

In general, the available records for other trapped species and moose did not show a dramatic effect of the diversion on the success rate for trappers and hunters (McKay 1984). However, detailed surveys are needed to determine precisely the diversion effects on wildlife but funds have not been available to to so.

Waterfowl

Surveys conducted in 1978 and 1979 suggested that reduced flows on the lower Churchill resulted in reduced use of the area by breeding ducks and geese. To minimize nesting disruption, it was recommended that Manitoba Hydro maintain consistent discharge in the Churchill from 10 May to 10 July each year. However, the need for more study was identified to determine the effect of wet and dry conditions in the Canadian prairie in displacing waterfowl to the boreal forest region and to determine trends in the lower Churchill waterfowl populations (Boothroyd 1981: 37-41). This project was cancelled due to lack of funds.

Socioeconomic Change

Social Impacts

Among the worst aspects of the planning for the Churchill River Diversion was the insensitive manner in which affected communities were handled. Manitoba Hydro took the position that its responsibility was limited to repair or replacement of facilities that were directly affected by the diversion; compensation for effects on fishing, trapping, and transportation was the responsibility of the provincial government (Tritschler 1979: 209). However, this responsibility was not assumed by the province. As a result, over the following 15-year period, Manitoba Hydro was progressively forced to achieve ad hoc settlements with no overall planning for the problem.

The high-level alternative CRD was conceived and planned with inadequate attention to environmental and social effects. When Hydro initially applied for a licence in April 1968 to build a high-level diversion, the project would have raised Southern Indian Lake by 10.6 m, flooded a large area of provincial crown land and areas occupied by Indians, and required the resettlement of several hundred people. Those to be affected were not consulted nor were procedures and funds for resettlement included in

project cost estimates. Public volunteer opposition led to the rejection of this poorly conceived proposal. Indeed, later studies by Manitoba Hydro revealed that the scheme would not have been workable and that the impact on the people and environment would have been totally unacceptable. Economic costs and benefits of the project had not been studied in detail (Tritschler 1979: 71, 81, 84).

When the low-level diversion was approved in 1971, problems arose due to the inadequate time available for planning and investigation of alternatives. The City of Thompson was not consulted in advance concerning potential changes even though they requested such discussions. Eventually the city had to confront the provincial government to have erosion-related problems corrected at a cost which exceeded $6.9 million. Although timely public participation and simple modelling would have created a bond of trust and confidence concerning the diversion among the Thompson population and politicians, by predicting the expected effects and specifying remedial measures in advance, the approach followed by Manitoba Hydro served only to alienate local opinion against the project (Farrell 1984). The low-level diversion also led to the resettlement of most of the Southern Indian Lake population.

Employment

Development of the Churchill-Nelson system over a 7-year period from 1973 to 1979 provided a major source of employment in northern Manitoba (table 4). The maximum annual employment level of 3355 peak period workers was achieved in 1974 and the activity was spread over 7 years (Canada, DIAND 1984: 4). Although precise records were not kept, the affected Indian bands received little work and what was available consisted mainly of land clearing and cleanup activities (Keeper 1984). At the time there had been no suitable training programs available to native people to make them competitive for higher paying construction-related jobs or for operational positions when the project was completed.

Table 4

Maximum Annual Peak Employment in the Lake Winnipeg, Churchill-Nelson Diversion and Regulation Project: 1973-1979

Project	1973	1974	1975	1976	1977	1978	1979
Kettle/Long Spruce	665	1485	1404	1177	708	274	211
Churchill Diversion	442	730	1071	393	125	--	--
Lake Winnipeg Regulation and Jenpeg	1012	1140	716	445	385	368	301
Others	---	---	26	252	585	99	--
	2099	3355	3217	2267	1706	741	512

When plans to construct the Limestone Dam were discussed in 1984, the provincial government announced its intention to insure that natives receive an equitable share of the work created. Unfortunately, training opportunities had not been established following completion of the first phase of the Lake Winnipeg, Churchill, Nelson regulation and diversion project in 1979 so that natives could not be assigned to skilled positions. However a commitment was made to place northern residents into apprenticeship and trainee positions in order to help develop a skilled local work force for the future (Parasiuk 1984: 16). Given the boom and bust nature of hydroelectric development, and most other northern development, it will be interesting to determine if the creation of a skilled native work force will eventually attract them away from their reserves to find new types of employment in the southern Canadian wage economy.

The Northern Flood Agreement (NFA)

When the low-level Churchill River Diversion alternative eventually constructed was licensed on 1 December 1972, neither Manitoba Hydro nor the provincial government had formulated a plan to compensate communities and individuals to be negatively impacted; those to be affected by the project were never consulted nor informed fully of what would happen to their communities. In 1973 they attempted to obtain a court injunction restraining Manitoba Hydro from proceeding with the development. The injunction was denied because the Churchill-Nelson impact studies were only partially finished and Justice Deniset considered there was insufficient evidence of damage to livelihood. Subsequently three native communities to be affected by the project joined with two others to be impacted by Lake Winnipeg regulation to form a legal corporation in 1974, the Northern Flood Committee Inc. (NFC). Subsequently NFC began negotiating with the federal and provincial governments in 1974 and 1975 concerning appropriate compensation. But until a mediator was appointed in February 1976, neither the provincial government nor Hydro would admit that reserve lands would be flooded by CRD. Finally, the negotiator forged a compact concerning compensation, the Northern Flood Agreement (NFA), in December of the same year among four parties: the Northern Flood Committee, the Government of Manitoba, Manitoba Hydro, and the Canadian government represented by the Department of Indian Affairs and Northern Development (DIAND). The main provisions of the agreement concerned the exchange of provincial crown land for any reserve land to be flooded on the basis of not less than 4 acres for each acre affected for the exclusive use of each band, compensation for loss of income from trapping and fishing, and a \$3.2 million contribution by Hydro and the federal and provincial governments to a development corporation, Neyanun, to be used for the benefit of the affected communities (Manitoba et al. 1977). An arbitrator was

appointed to resolve issues when agreement could not be reached by the four parties. Damages experienced in Southern Indian Lake and other crown lands were not covered by the agreement.

While well intentioned, the Northern Flood Agreement was flawed in many respects. Most seriously, Manitoba and Canada did not give specific agencies and personnel a mandate to implement the agreement. Money was not set aside by either senior government to implement NFA and projects and activities which needed to be undertaken were not specified in the agreement, particularly monitoring studies which could quantify the location and quantity of damages. And there were no provisions for review and safeguards to ensure implementation. Indeed, some objectives of the agreement such as the eradication of mass poverty, mass unemployment, and the improvement of physical, social, and economic conditions and transportation for the bands could simply not be achieved without a carefully prepared plan, manpower, and committed funds; most of this work could not be achieved in a short period. In effect, parts of the agreement were unrealistic and misleading.

New Institutions

In light of the slow progress being made to implement the agreement, Manitoba created an office to manage and coordinate provincial interests in its Department of Northern Affairs and Canada established a Resource Development Impacts Office within the Winnipeg DIAND office in 1982. These new institutions, cooperating with Manitoba Hydro, made rapid progress settling claims submitted by the 5 bands. The appointment of an aribitrator was especially significant in resolving difficult cases.

Outstanding NFA Issues

Twelve years after the Churchill-Nelson-Lake Winnipeg project was authorized in 1972, and 8 years after it became operational in 1976, there were less than 100 claims outstanding of more than 1000 claims filed for damage against Manitoba Hydro; of approximately 150 claims submitted for arbitration less than 100 of these remained to be settled. In general, the expensive collective class action questions were unresolved (Miles 1984). Manitoba Hydro's recent $30 million offer was an attempt to settle these claims in perpetuity.

Among the more serious of these were ecological and economic impacts induced by the projects. Although the Lake Winnipeg, Churchill, and Nelson Rivers Study of 1975 recommended that a mechanism be established to deal with social and related economic issues, and that appropriate agencies develop long-term coordinated ecological monitoring and research programs, this was not done (Canada-Manitoba 1975:

Recommendations Nos. 5C and 10). These two recommendations were subsequently incorporated into the Northern Flood Agreement. When little integrated action was taken on this matter, NFC submitted a claim to the arbitrator in December 1981 which led to the commissioning of a study by Manitoba Hydro to develop a useful biophysical monitoring program. Their consultant found that although many agencies had monitored a variety of parameters over a number of years, the work had never been conceptualized and coordinated into a comprehensive monitoring program and that it was impossible to determine which issues had been adequately considered. Hydro's consultant recommended that Manitoba Hydro initiate and coordinate a $2.3 million ecological monitoring and data management program over an initial 5-year period. It would focus on those questions most important to diversion area residents: wildlife, fisheries, archeology, geomorphology, water quality, and transportation. The study would incorporate the expertise and experience of a wide variety of actors familiar with the area or the subject fields. Considerable time would be devoted to data analysis, hypothesis testing, and mid-term and final review of the approach adopted and outstanding issues (MacLaren Plan Search 1983). This belated effort was made necessary because the provincial and federal governments had largely missed the opportunity to monitor and compare conditions before and after the diversion.

The proposed monitoring study design was criticized by many interests on the grounds that almost 10 years after project completion it is difficult to establish preproject baseline conditions to determine project-related changes and that it did not deal adequately with current concerns such as ice travel and navigation. There has been no progress on this proposal to date.

Compensation payments by Manitoba Hydro until December 1983 for the diversion was $38.6 million (Manitoba Hydro, Mitigation Department 1985). Most of this was for remedial works to replace improvements destroyed by the projects although $4.5 million was spent to keep trappers and fishermen working in their traditional employment and to create a new native village at South Indian Lake (Manitoba Hydro Dec. 1983). In addition, the fishermen and hydro signed a $2.5 million final settlement in 1984 for Southern Indian Lake fisheries losses. The Manitoba government has also paid approximately $3.5 million toward the NFA settlement (Miles 1984).

In July of 1984 the federal government made an effort to accelerate implementation of the agreement. A $70 million cooperative federal-provincial program was announced which would include water and sewage services for the five bands, community planning and development assistance, $500,000 operating expenses

annually for the 5 NFC bands for 5 years, and ecological monitoring (Canada, DIAND 1984). In addition, Manitoba Hydro offered the bands $30 million in 1982 to settle, in perpetuity, all resource-related claims attributable to the Lake Winnipeg-Nelson-Churchill regulation and diversion project (Keeper 1984).

In effect, the concerns of the affected communities and the protracted and bitter negotiations among the Northern Flood Committee, the Manitoba government, and Manitoba Hydro were the result of inadequate engineering and environmental knowledge and a development strategy which placed little importance on local inhabitants who would be negatively affected by the project. Indeed, the Northern Flood Agreement was not achieved until the diversion was operational and it appears that the resolution of most induced problems will take more than a decade.

Economic Effects

In December of 1972, the government of Manitoba established an internal task force to advise on important issues related to financing and accelerating the lower Nelson development, energy pricing, and long-term power exports from the Lower Nelson plants. Two members of the Task Force, Eric Kierans and Marc Eliesen, were particularly critical of Manitoba Hydro and they recommended: the existing pace of development should be reduced because capacity would exceed the needs of provincial users adding to a heavy provincial debt load, that energy prices for mining and export be raised to increase the reserves and net worth of the utility, and that discussions of accelerated capacity development for exports be terminated. These reports were not made public nor did they receive adequate debate (Tritschler 1979: 221-34). The development of the Lake Winnipeg, Churchill, and Nelson regulation and diversion project continued rapidly without heeding this warning.

With the advantage of hindsight, several decisions during the planning stage contributed to the lack of profitablity of CRD. Construction costs were consistently underestimated and firm energy sales contracts were not arranged prior to construction. Partially as a result of the diversion and the Kettle, Long Spruce, and Limestone projects, Manitoba residents carried a debt burden per capita that was the second highest among Canadian provinces (Tritschler 1979, 26). The average energy cost from Kettle and Long Spruce, 19.7 mills per KWh, was only slightly higher than the 17.5 mill generation and transmission system average in 1982-83.

Although significant revenue is generated by diversion-related energy, Long Spruce exports to the United States, Saskatchewan, and Ontario are made at a loss because of the comparatively low revenues received for the interruptible power sold (Tritschler 1979: 410). For example, 41% of system energy, mostly interruptible, was exported in

1982/83 at an average wholesale rate of 13.8 mills per KWh while Manitoba customers paid an average of 20 mills (Manitoba Hydro 15 Nov. 1983). However, there are no distribution costs associated with the export energy. In effect, assuming the energy exported was from Kettle and Long Spruce, there was a 5.9 mill subsidy on energy exports or roughly 43% of the cost of production. On the other hand, Manitoba consumers would have paid 28.9 mills per KWh if the energy had not been sold, due to the surplus of available power.

There are clearly major lessons to be learned from the Churchill Diversion experience. However, it is important to note that a judicial inquiry found little fault with the technical expertise of the lower and middle level Manitoba Hydro professional staff. The Tritschler Commission attributed most problems encountered to lack of direction and control by the provincial government and inappropriate judgements and decision making procedures followed by senior Hydro officials. The problem of the independence of Manitoba Hydro has been corrected by creating a government agency, the Manitoba Energy Authority, to oversee the utility's operations and by making the Manitoba Hydro-Electric Board more independent.

Seven years following the initial operation of the diversion, Long Spruce and Kettle Rapids, the two Nelson River plants using Churchill River water, generated 63% of the provincial energy produced during 1983-84 (Manitoba Hydro-Electric Board 1984: 16). During that year, Manitoba Hydro had 1088 MW (25.6%) surplus system capacity after meeting the provincial demand and reserve requirements and 6931 GWh (33%) of surplus energy was exported for a return of $105.7 million (Manitoba Hydro 1984a and 1984b). Normally, interties with neighboring utilities which are capable of exporting 60% of the installed provincial hydraulic capacity have been sufficient to permit surplus energy to find a market, albeit often at extremely low rates.

Little water is spilled from the Manitoba Hydro system without generating energy. The exceptions are at the Kelsey plant on the upper Nelson which has inadequate installed capacity to use the available water. In addition, spills were made during the 1979 flood at the Long Spruce and Kettle plants (Abel 1984).

As a result of the lower provincial demand for energy than predicted, increasing interest rates, and the decreasing value of the Canadian dollar, net interest costs increased from 38.6% of total Manitoba Hydro expense when the diversion was completed in 1977 to 54.2% in 1979. Net interest payments reached $229 million in 1984 on net assets of $2.9 billion (fig. 12) (Manitoba Hydro-Electric Board 1984: F14). These payments are a major burden on the utility.

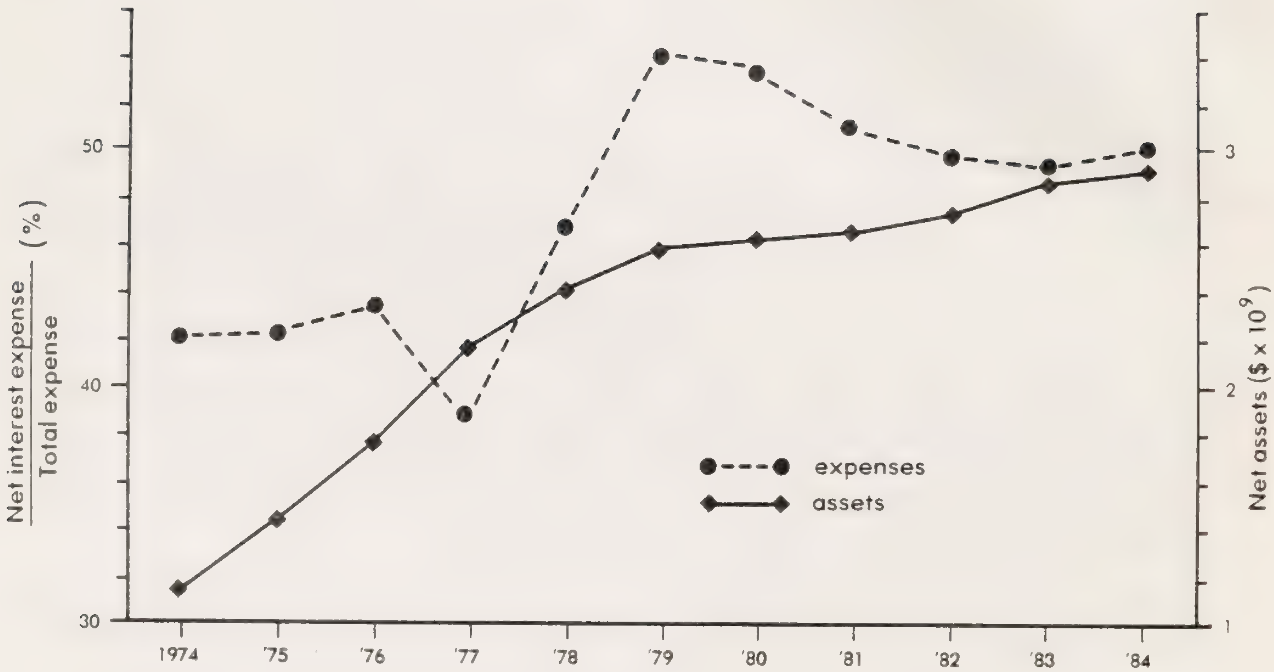


Figure 12. Manitoba Hydro net interest payments and net assets: 1974-1984

The projections on which the provincial demand for diversion related energy were made in 1970 were not realized as demand did not grow at the expected rate. Initially it had been assumed that the 1200 MW Limestone plant would be needed by 1983 but this date was subsequently extended as late as 1992 as the rate of growth in energy demand began to drop in 1975 (Manitoba Hydro-Electric Board 1976: 13; 1983: 8).

Energy Exports

When the Churchill Diversion was initially recommended, energy export was considered to be an element in the strategy to increase the profitability of the project (Canada and Manitoba 1965: 1-8). The concept of energy export became much more important in 1984 when Manitoba Hydro made an application to the National Energy Board to approve an export agreement based on the construction of a new dam. Hydro requested a licence to export 500 MW at 75% capacity factor for 12 years beginning in

1993 to the Northern States Power Company in central Minnesota. This would be approximately 50% of the capacity of the proposed Limestone plant. As a result, the 1200 MW Limestone plant would be completed in 1990, 2 years earlier than anticipated, to ensure that adequate power and energy existed in the provincial grid to meet the firm export contract over an existing 500 KV interconnection. The project was intended to act as an economic stimulus to create employment and demand for Manitoba goods and services during a period of slow economic activity. It was anticipated that the $3.1 billion undertaking would create a total of 8020 peak work force jobs over an 8-year construction period with up to 1800 workers employed during two years (Parasuk 1984). An additional 11,000 person years of indirect work would also be created. The sale was expected to generate $3.2 billion in revenues and a $1.7 billion profit for Manitoba which would be used to pay all of Manitoba Hydro's costs and a significant proportion would be transferred to meet other provincial spending priorities (Manitoba, Department of Energy and Mines 1984). No mention has been made of incremental disruption, if any, to residents along the Churchill-Nelson diversion route.

In June 1984, a letter of intent was also signed with the Western Area Power Administration of Golden, Colorado to negotiate the sale of hydro power from another new generating station on the Nelson. The 1200 MW firm power export could begin in 1993-94 for a 35-year period. The sale would require construction of the 1270 MW Conawapa Station on the Nelson costing in excess of $3 billion. Two additional interests, the Minnesota-Wisconsin Power Supplier's Group and eight other utility groups are both discussing the potential purchase of 1100 MW of power over a 15 to 35 year period (Eliesen 1984: 8-11). These contracts would involve the construction of addition hydroelectric capacity using diversion-related water.

The recent provincial hydroelectric development strategy induced heated debate. The provincial Progressive Conservative opposition charged that the Limestone project was a dangerous currency speculation. The province would be exposed to enormous potential losses related to fluctuations in interest rates, inflation, the Canadian dollar, construction cost overruns, and borrowed foreign currency during the project construction period. Conversely, the American consumers would have substantial price increase protection for a 12 year period beginning in 1993. They alleged that the risk to the Manitoba economy were not worth the comparative short-term advantages of employment and economic growth (Enns 1984; Filmon 1984).

Energy Transmission

Manitoba Hydro is also upgrading its transmission capability. Within the province, the high voltage direct current capability from the Nelson River is being doubled from 1800 to 3420 MW to improve reliability and performance (Manitoba Hydro-Electric Board 1984:11). Ultimately the system will carry energy from the Kettle, Long Spruce, and Limestone stations (Tritschler 1979: 37, 41, 404). The utility is also attempting to construct a 600 mile 500 KV intertie to permit a 700 MW seasonal diversity exchange with a group of utilities led by the Nebraska Public Power District (Eliesen 1984: 14). These expensive projects are made necessary, in part, to sell surplus diversion-related energy.

A Summary Assessment

1. The Churchill-Nelson Diversion was conceived as a technical engineering problem by Manitoba Hydro; specialists from the biophysical and social sciences neither held responsible positions in the decision making hierarchy nor was any attention devoted to such questions before the project was approved. Hindsight evaluation has demonstrated that geotechnical and engineering predictions were inaccurate and that part of the diversion and power development was premature.
2. Power planning totally dominated resource decision making in the diversion area. Long-term provincial plans were not formulated for the use of other resources and consideration of project effects on these aspects of the resource base were all reactionary.
3. Provincial agencies responsible for resource management were given neither the manpower nor funding to evaluate and monitor the resource base and changes induced by the diversion.
4. With the exception of manpower for planning and impact studies and the Southern Indian Lake biophysical evaluation by the Freshwater Institute, the federal government contribution to the Churchill Diversion was basically funding. Little was done to compensate affected band members from negative diversion effects for more than a decade following project construction.

THE JAMES BAY PROJECT

Historical Developments

The James Bay development was initially proposed in 1971 to satisfy future hydroelectricity needs in Quebec and as a source of energy to sell to the northeastern United States at a profit. The cost was to be $2 billion (Richardson 1975: 327-330; 1972: 7-17). Over the next 2 years the alternatives were examined in detail and the decision was made to begin initially with the massive potential of La Grande River Basin which had an average flow of 1630 m^3/s. This represented an enormous commitment of money and manpower. Approximately 1000 km north of Montreal, the La Grande River drops 376 m over its 800 km course from east to west before reaching James Bay. Its 98,000 km^2 drainage basin is more than twice the size of Switzerland (fig. 13) (Societe d'energie de la Baie James 1983: 31).

To maximize the output from hydroelectric stations, water was diverted into the La Grande from adjacent drainages. From the south, 810 m^3/s (87%) of the Eastmain River flow was redirected into the LG2 reservoir and 776 m^3/s (43%) of the Caniapiscau River was redirected into the LG4 reservoir, eventually to flow through all four powerhouses. A third smaller interbasin diversion transfers 31.35 m^3/s north from Frigate Lake on the Sakami River into the LG3 reservoir rather than allowing it to enter the LG2 impoundment via Sakami Lake. Collectively these diversions, which add an average 1586 m^3/s, nearly doubled the natural La Grande River flow and increased the basin area to 176,810 km^2. Eight main dams and 198 dikes which were required to form the five major reservoirs of the La Gande complex are 125 km long and required 156 million m^3 of fill (Societe d'energie de la Baie James 1982: 1.7, 5.6; 1983: 33-35).

Cost escalation has been a continuing problem. When the decision was made in May 1972 to proceed with the La Grande complex based on preliminary knowledge the government cost estimate was $5.8 billion involving 4 generating stations with a capacity of 8330 MW. Expenses increased quickly as detailed studies were conducted. Within two years the expected cost became $12 billion and finally $14.6 billion (Richardson 1975: 333-335).

Ultimately three hydroelectric plants with a combined head of 336 m and 10,300 MW capacity were constructed in phase I of the project: La Grande 2, 3, and 4. With an installed capacity of 5328 MW, LG2 is the most powerful underground generating station in the world and it provides 35.8 billion kilowatt-hours of energy annually. LG3 and LG4, with a collective capacity of 4954 MW, produce 74% of the LG2 yearly output. The first energy was generated at LG2 in 1979 and LG4 is expected to be completed in 1985. The construction of LG1 has been deferred to phase II of the project.

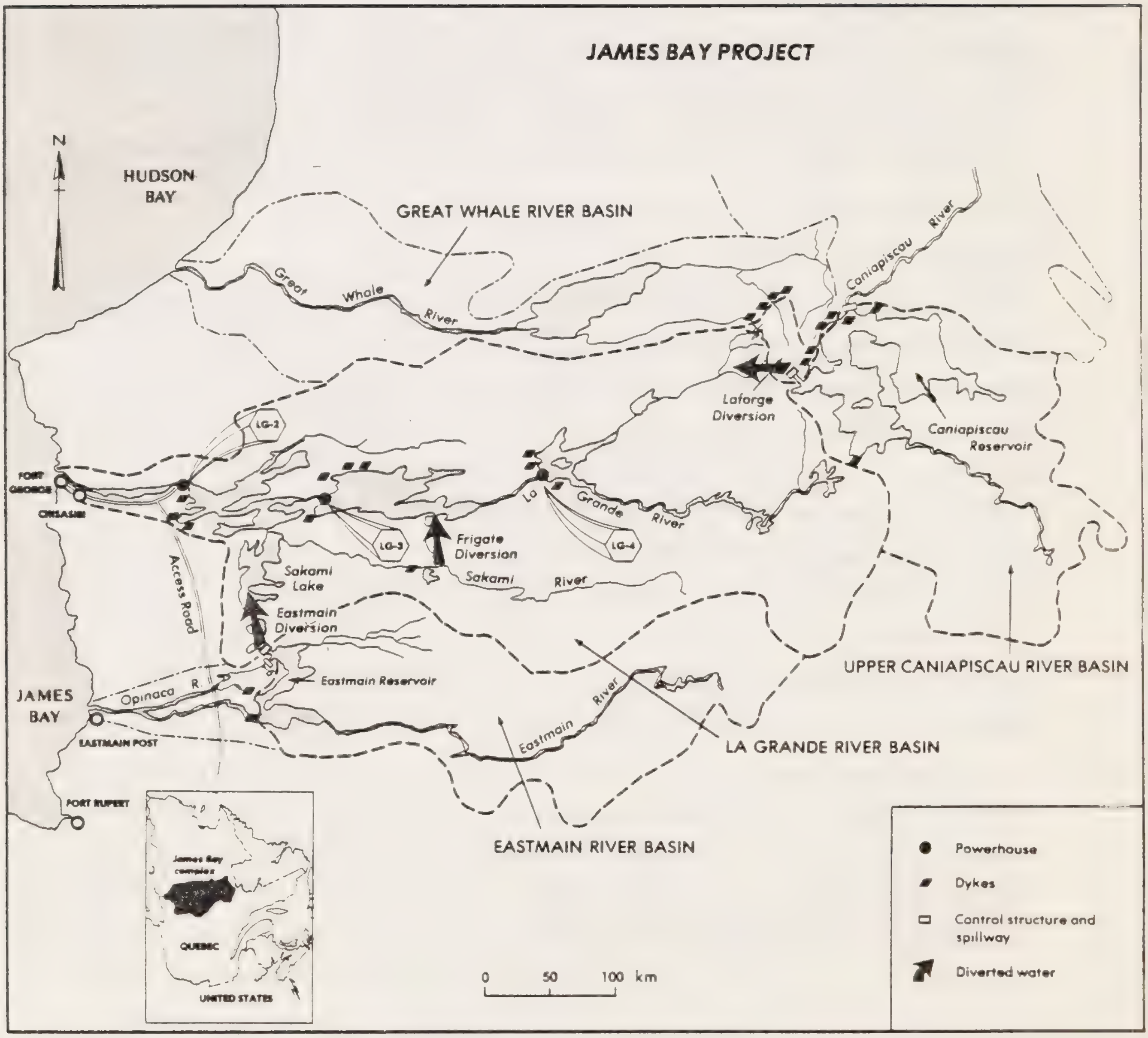


Figure 13. The James Bay Project

Five 735,000 volt transmission lines will carry the energy from the phase one plants over nearly 5000 km of lines to Quebec's urban centers and export interties with Ontario, New Brunswick, and the United States. This system will cost approximately \$3.7 billion. The total phase I cost is estimated at \$14.6 billion.

Institutional Developments

Many changes induced by the Ogoki, Long Lake, and Churchill-Nelson diversions reported above were also observed in the James Bay project. But the approach to deal with them has been significantly different. Four major groups have been involved in studying the biophysical environment. Initially, the Cree and Inuit engaged scientific and legal advisors to assist them in establishing an aboriginal rights claim to the project territory and in determining what impacts the proposed projects would have on their land. This work was funded by the federal government.

Shortly after the James Bay project was announced, a federal-provincial task force recommended a program of biophysical inventories be undertaken to obtain baseline information for impact assessment in the project area. A 7-year joint study was initiated to evaluate the fresh water, marine, and terrestrial environments as well as the atmosphere, geology, flora, and fauna. These data were subsequently used in locating transportation corridors, forestry planning, and a beaver trap-out and relocation program although they could not be applied to land use planning problems because the information was not available in a manageable form at the time it was needed (Societe de Developpement de la Baie James 1982).

As part of the James Bay Agreement a joint corporation, the La Grande Complex Remedial Works Corporation (SOTRAC), was formed by the Cree and the James Bay Energy Corporation. Its board of directors is composed of 5 members: 2 appointed by the Cree, 2 from the James Bay Energy Corporation, and a fifth nonvoting Cree member. The rationale for this body was that potential impacts and required remedial measures could not all be predicted at the time of the James Bay Agreement. This corporation was created to plan, evaluate, execute, and operate remedial works related to Cree fishing, hunting, and trapping. A fund of \$30 million was established to conduct this work with an initial annual payment of \$250,000 in 1976 which increased up to \$2.5 million and a final payment of \$15 million in 1986 (Quebec 1976: Section 8.9). This adaptive strategy has been beneficial in responding to community and individual requests for assistance; the corporation has never had to submit a dispute to arbitration (SOTRAC, annual reports).

Another innovation concerned the creation of a Department of Environment within the James Bay Energy Corporation with a mandate to ensure that all laws and regulations for environmental protection were met and that ecological considerations received the same consideration in project design as technical and economic matters. It undertook major studies beginning in 1973 to determine corrective measures needed to reduce biophysical impacts concerning means of natural deforestation, floating peat bogs, fisheries, the re-establishment of flooded terrestrial habitats, and the revegetation of disturbed sites (Soucy et al. 1977). Its studies and remedial works have continued to the present time.

In response to the Malouf injunction which is discussed below, the James Bay Agreement, and an enquiry conducted in 1976 and 1977 by the Quebec Consultative Committee on the Environment, the James Bay Energy Corporation initiated a series of sectoral impact assessments of components of the La Grande project. The annual commitment over an 8-year period of 2 - 2 1/2% of the engineering budget to environmental studies, mitigation, and environmental engineering was a major innovation of the James Bay development worthy of consideration in other projects (Penn 1985).

Biophysical Change

Phase I of the James Bay project will not be finished until 1985 and the first completed reservoir, LG2, has been in operation for less than 5 years and most others for a much shorter time. As a consequence insufficient time has elapsed to observe all of the biophysical changes that will be induced by the project. A description of selected major modifications follows.

Eastmain and Opinaca Rivers

Spillways on both of these rivers completely stopped the westward flow in 1979 and 1980 and permitted diversion of all flows north to the La Grande except during very large flood flows. This initiated a complex series of interrelated changes. There was as much as 90% flow reduction at the river mouth which caused a 1 to 4 m reduction in wide sections of the river and an increased flow-through time. As the river level fell, parts of the former river bed became river bank which was unprotected by vegetation. This reduced the rate of erosion but increased turbidity due to undercutting, landslides, runoff, and gullying in the main channels as well as downcutting in the tributaries. Generally the river water became enriched in dissolved minerals and organic materials. There was a short-term increase in fish catches due to concentration in the remaining pools and, with the exception of northern pike, the formation of habitats suitable for the spawning of most major species although lake whitefish and lake sturgeon quality

declined. There was no change in the winter habitat of terrestrial fauna but a decrease in the summer food for moose as a result of a decline in aquatic plant communities and reduced potential for muskrat due to river bank erosion. In the estuary, the mean tide range increased and the saltwater front advanced upstream in some cases to Eastmain where increased turbidity and deposition of mud caused village water supply problems. As a consequence, native people who traditionally harvested this area believe there are fewer fish and fur-bearing animals, navigation upstream of Eastmain is more hazardous, snowmobiling in the estuary is made difficult, and access to certain river sections is reduced (SEBJ and STCCLG 1983).

In an effort to mitigate negative downstream effects below the spillways the James Bay Energy Corporation and SOTRAC undertook corrective actions including seeding and transplanting along exposed shores and the construction of 4 weirs. This resulted in restoration of prediversion water levels and an increase in flow-through time, a reduction in erosion and turbidity, but maintenance of the richness of dissolved minerals and organic matter. Generally habitats for aquatic fauna, northern pike spawning, and summer moose food supply were restored and conditions for canoeing and float planes improved. However few nesting pairs of wildfowl were observed. Seeding quickly produced a good vegetation cover which helped check erosion and improved habitat (SEBJ and STCCLG 1983).

Fish

An extensive monitoring program is underway to trace the effects of the James Bay hydrological modifications on fish. Pike populations increased dramatically following reservoir filling. Walleye did not begin to reproduce for 5-years after flooding of the LG2 reservoir even though spawning habitats had been preconstructed. In the Opinaca Reservoir where there was less inundation, this has not been a serious problem (Roy 1982). However, considerable time will be required to determine how the fish will adjust to reservoir drawdowns that range between 13 m in the Caniapiscau to 4 in the Eastmain-Opinaca. Reduced flows downstream of LG2 during the reservoir filling between November 1978 to November 1979 caused the saline front to vary between 6 and 20 km from the river mouth. This induced a complex set of movements in 20 species of freshwater, marine, and anadromous fish with differential tolerance to salinity variations (Boucher et al. 1984: 38). Low flows during the filling period and then a subsequent doubling of flows when the diversion became fully operational will undoubtedly influence water temperatures, historic spawning grounds, and possibly the availability of fish for native families (Berkes 1977: 65).

One of the most important fisheries problems that developed was the release of mercury from land in flooded reservoirs. Mercury levels in fish in the reservoirs exceed the Canadian consumption limits by 2 to 5 times. Because of the enormous distances to southern markets, a commercial fishery had not been established in the area when work on the project began; the fish were used for local subsistence needs. It is unknown how long will be required for mercury levels to return to normal so that new patterns of subsistence and sport fishing may develop.

Erosion and Turbitity

In general, erosion and turbidity are not major problems in the reservoirs and diversion channels in the James Bay project in comparison to the Southern Indian Lake experience. Where erosion did occur after reservoir filling, shoreline armoring normally occurred rapidly. Cattails were planted in Sakami Lake to reduce erosion and create habitat. Doubling the La Grande flow downstream from LG2 also doubled turbidity although the level remains relatively low.

Vegetation

Logs in the reservoirs and flooded lakes have been a major concern. Because of the enormous distance to markets and slow tree growth, commercial forestry was never practiced in the project area. In critical areas such as the rims of reservoirs, future spawning grounds and the banks and mouths of rivers, trees were cut and burned before flooding; elsewhere the action of ice was used to break the stems. A floating incinerator is currently working in the Eastmain-Opinaca Reservoir and others in an effort to dispose of the floating debris which is created by this process of tree removal.

A major effort is underway to revegetate disturbed sites associated with phase I of the James Bay project to minimize erosion and create wildlife habitat. Approximately 5700 hectares are being planted with seedlings and an additional 300 ha with grasses.

Archaeology

The waterways were the main historic transportation routes and the shores were the traditional sites for aboriginal and European settlements. Diversion-related flooding and erosion pose major threats to the archeological record. There was a belated effort in the La Grande basin to locate and excavate sites which would be potentially disturbed. The Cree have organized a museum project to store and display recovered materials within their territory (Craik 1985).

Social Change

Approximately 6650 Cree-speaking people lived in Northern Quebec in eight villages, five situated along the James and Hudson Bay coast and three 500 km inland. An additional 4386 Inuit lived in 15 villages north of the Cree (Canada 1979: vi; 1982: 5). The Cree were isolated and there was virtually no communication among the inland bands although the coastal communities were better connected by water transport. The James Bay Cree rely heavily on the traditional use of animal and forest resources; the Inuit are more dependent on the marine environment. Their way of life is inextricably tied to the water ecosystem and any effects resulting from man-induced change to the ecosystem has the potential to detrimentally affect both groups (Moses 1984).

When the decision to build the James Bay hydroelectric project was announced in 1971, the initial Cree and Inuit reaction was one of shock at not having been informed and consulted, at the extent of inundation of their hunting lands, at the impact the project would have on wildlife that provide a substantial portion of the Cree diet, at the impact on their hunting activities, at the social consequences of the massive influx of nonindigenous workers to the territory, and at the uncertain economic effect on the Cree (Feit 1980: 159). Ultimately the potential effect of the project on the Indian population was to unite these bands into the Grand Council of the Cree of Quebec.

In response to the initial Cree and Inuit attempt to discuss the project, the Quebec government took the position in 1972 that the plans were not negotiable and that the indigenous people had no special rights. In an effort to force a decision concerning their rights to the land, the Cree and Inuit to be affected by the project sought a court injunction to stop construction work in 1973. Justice Malouf granted the injunction the following year and ruled that construction could not proceed without prior agreement of the Indians and Inuit (Malouf 1973: 38). Even though a higher court ruled to suspend the injunction within a week, the Malouf judgement made it impossible for Quebec to ignore the Cree and Inuit case; within five days of the Malouf decision, Quebec announced it was ready to negotiate and within two weeks it presented the Cree and Inuit with a proposed settlement.

The James Bay and Northern Quebec Agreement was signed in November 1975 by the James Bay Cree, the Inuit of Northern Quebec, the governments of Quebec and Canada, the James Bay Development Corporation, The James Bay Energy Corporation, and Hydro Quebec. The agreement was a recognition of aboriginal land rights. The main aim of the settlement was to give the native parties the means of ensuring their cultural vitality and of preserving their traditional way of life while taking advantage of the

economic opportunities and benefits arising out of the development of Quebec's northern territories. The Cree and Inuit obtained protection of their traditional hunting, fishing, and trapping rights and a priority on the use of certain animals in the region. Certain lands were set aside for their use as traditional reserves and village corporations. The Cree secured promises that if substantial modifications were made to the James Bay project, another agreement would be arranged first, that remedial works would be constructed to minimize environmental damage, and that cash compensation of $225 million divided proportionally between the Crees and Inuit would be paid over 20 years until 1997 (Quebec et al. 1976).

New Native Institutions

In order to implement the agreement, the Cree and Inuit had to create an entirely new governmental structure. The agreement provided for several dozen committees, municipal corporations, authorities, boards, and other legal entities through which it was intended the native people would gain control over their affairs. For example, the Cree Regional Authority controls the administrative structure of the bands. Special purpose boards have been created to administer programs related to health and social services, schools, income security, housing, arts and crafts, trappers, and construction. Natives are also intimately involved in the administration of justice and policing. Today the Indian communities are physically integrated into the communications and transportation networks of the province and they can communicate with each other. In an effort to stimulate economic development, the Cree and Inuit both established airlines and the Cree established a holding company to sponsor new initiatives such as forestry, mining, tourism, and transportation. The native parties have also established research programs related to waterfowl, country food, and other interests to enable scientific resource management. Similarly the Inuit created commercial construction and travel firms. All of these changes were innovations induced rapidly by the project (Canada 1979: 29-38). During the first six years, until 31 March 1981, the federal government spent $178 million on programs, services, and benefits for the native parties (Canada 1982: 106). However, it is unclear how much would normally have been spent for continuing commitments in the absence of the agreement.

Agreement Implementation Problems

Major disputes arose between the native parties and Canada and Quebec related to the failure of governments to fulfill their obligations under the agreement. Basic to this feeling was the realization that the value of the compensation package will shrink a minimum of 26% as a result of inflation during the implementation period; that urgent

housing, school, and other infrastructure needs would not be met quickly, that health care has been inadequate, that economic development had not been stimulated, that there had been insufficient funding to handle local and regional administration, that the system of justice was inappropriate to the native culture, and that there was little attention paid to implementing and reporting progress in violation of the 1975 agreement (Canada 1982). When 8 Cree children died as a result of gastroenteritis induced by contaminated drinking water, overcrowded housing, lack of sanitary facilities, environmental contamination, lack of adequate medical services, and poor preventative medicine, the Cree and Inuit mounted a concerted lobbying campaign in 1980 in an effort to force Canada and Quebec to live up to the terms of the agreement. Investigation revealed that although the native parties had given up their aboriginal title to lands affected by the diversions in exchange for improved social and economic services, safeguards had not been written into the agreement to insure that the senior governments would be obligated to deliver the programs (Epstein and George 1982).

In response to persistent complaints by the native parties, parliamentary review clarified what had gone wrong with the James Bay Agreement. No special funds had been allocated by Canada to enable implementation of the promised changes; no one had been appointed and impowered to insure that the agreement was implemented; and the required annual reviews of the level of implementation had been neglected. Indeed, a senior official of the Department of Indian and Northern Affairs in Quebec revealed in 1980 that the enormous cost of implementing the federal share of the James Bay Agreement exceeded the financial resources of his agency (Canadian Press 9 April 1981: 21). Equally serious was the problem of divided jurisdiction for implementation among federal and Quebec government agencies. For example, the federal health minister disclaimed association with the gastroenteritis problems in 1981, claiming that responsibility for health and environment had been transferred to the Province of Quebec and that infrastructure such as sewage, garbage, and housing were controlled by the federal minister of Indian Affairs (Strauss 1981: 24).

Supplementary Arrangements and Institutions

Nine years following the original James Bay Agreement the federal government passed supplementary legislation designed to provide a legal and financial basis for the Cree and Naskapi to assume responsibility and control for their own forms of self government in the way the native parties consider most appropriate (Canada, DIAND 8 June 1984). By giving the bands status as legal corporations, they were empowered to interact with other governments, make contracts, and take legal action. The role of the

federal minister of Indian Affairs in supervising local government as established in the Indian Act was drastically reduced. The bill provided a 5-year budget to initiate long-term planning by the bands (Canada, DINA 1984).

Belatedly realizing the provisions of the James Bay Agreement do not fall within its traditional programs, DINA also created a special secretariat to oversee implementation of the agreement. Experts familiar with the language and culture of the native parties were appointed to begin this work supported by $11 million of the $61.4 million of special funds to construct promised airstrips, housing, schools, and water systems (Canada, DIAND 19 Feb. 1984). However the native parties are concerned that although it was initially promised the secretariat would report directly to the minister to ensure that the agreement was carried out expeditiously, in fact, the secretariat controls little of the money and it reports to a deputy minister; the secretariat has no power to ensure compliance. It is comparatively low in the DIAND reporting structure resulting in inordinate delays on urgent matters (Simon 1984: 47) with no control over other federal departments (Diamond 18 Oct. 1984; Gordon 18 Oct. 1984)

The Federal Role

The Cree of Quebec feel that the federal government has played an inadequate role in monitoring the biophysical effects of the James Bay project. They assert that the federal government has tended to treat large-scale hydroelectric diversions and plants as essentially provincial in character and to assume that the provincial government is fully responsible for investigating the resulting ecological impacts and associated remedial actions. The Cree assert that the estuarine studies of the James Bay Energy Corporation and Hydro Quebec are too short term and inadequate; that the federal government has jurisdiction and is responsible for undertaking monitoring in Hudson and James Bays; and that important issues which the federal government identified related to changing winter circulation patterns and nutrients in James Bay have not been followed up. The Cree also indicated that the federal government has an obligation to study the mercury problem associated with creating new reservoirs because of its impact on the subsistence fishery and native health (Moses 1984).

Economic Effects

Manpower and Economic Impacts

Planning and construction of the James Bay project required large numbers of workers. The manpower policy adopted was that contractors, rather than the James Bay Energy Corporation, would hire personnel giving northern Quebec residents first priority, followed by other Quebec residents, and then workers from outside the province. Peak

annual employment during the construction period varied between 4192 in 1983 and 17,003 in 1977 (table 5).

Table 5

Annual Peak Employment: James Bay Energy Project, Phase I[a]

Year	Maximum Employment
1976	7,244
1977	13,657
1978	17,003
1979	16,153
1980	15,262
1981	12,973
1982	6,404
1983	4,192

Source: l'Association des employeurs de la Baie James n.d.: 25.

The James Bay Energy Corporation has made a continuing effort to hire members of local native bands. Between 1975 and 1983, the peak number of native employees who worked at least 10 days annually ranged between 127 and 552 (table 6) and they worked in a variety of unskilled and semi-skilled positions as laborers, forest workers, drivers, heavy-equipment operators and mechanics, tradesmen, janitorial staff, camp maintenance workers, and office clerks. However, Moss observed that there is a lack of educational programs for natives in highly skilled, technical, and professional fields to insure that Crees will participate as permanent employees during the operational phase of the project (Moss 1982: 22-25).

Table 6

Annual Peak Native Employment: James Bay Energy Project, Phase I[a]

1975	255
1976	127
1977	302
1978	485
1979	537
1980	552

[a] Source: l'Association des employeurs de la Baie James n.d.: 47.

The $11 billion construction budget for phase I of the La Grande project resulted in $3.7 billion dollars in direct wages and $1.9 billion in indirect wages paid to Quebec workers. Of goods and services purchased, $4.75 billion (65%) were from Quebec and $0.8 billion (11%) from other Canadian provinces (SEBJ 1984). Clearly, the project had a major impact on the Quebec and Canadian economies and manpower needs over the 1975 to 1985 decade.

Energy

Since the initiation of production, the La Grande complex energy contribution to the provincial grid grew from 1% in 1979 to 33% in 1983. By 1983, the La Grande complex had added more than 7000 megawatts to the 21,300 MW system, 97% of which was hydroelectric (Santerre 1984: table 5).

Table 7

La Grande Energy Production (GWh)[a]

	Total Quebec System	La Grande	La Grande / Total System %
1979	70,543	649	1
1980	76,494	11,449	15
1981	80,580	16,874	21
1982	78,821	18,460	23
1983	88,321	25,207	29
1984	103,000	34,300	33

[a] GWh denotes gigawatt-hours or 10^9 watts

Financial Implications

When the James Bay project was planned, electricity demand was projected to increase by 6% annually until the 1990's. Since 1980, however, the provincial expansion in demand, which averaged nearly 7% during the 1970's, fell dramatically as a result of the recession: 2.8% in 1981; -3.1% in 1982; and 3.9% in 1983. This downturn occurred as the James Bay capacity was being rapidly completed resulting in a potential cummulative surplus between 1981 and 1987 of 291 TWh. Recently Hydro-Quebec decreased its long-term consumption estimates to reflect a scenario under which average annual provincial demand for firm electricity will grow at 3.3% between 1983 and 2001, less than half the rate of growth considered most likely when the project was approved (Hydro-Quebec 1983: 4-7). The utility's long-term debt increased from $10.4 billion in 1979 to $16.5 billion in 1983 and, in combination with the falling Canadian dollar and increasing

interest rates, Hydro-Quebec's annual interest payments rose rapidly during the same period from $1 billion in 1979 to $2 billion in 1983; these expenditures are anticipated to reach $2.3 billion by 1987. Hydro-Quebec reacted quickly by taking action on several fronts in an effort to sell the massive surplus and cut its financial losses.

Energy Marketing

A major initiative was taken in 1982 in an effort to reduce the large surplus of diversion-related energy in the Hydro-Quebec system by stimulating electricity consumption in all sectors of provincial energy users. This effort was also intended to reduce Quebec's dependence on imported energy. Subsidies offered to residential, industrial, and commercial customers to convert to electricity resulted in 51,000 residential conversions to electric heating and 52,000 homes and multi-family dwellings with dual heating systems. Similarly new offices and commercial buildings were encouraged to choose electric heating. And a program to promote the purchase or replacement of electical boilers as well as a 50% price reduction on large blocks of incremental industrial power to 1987 with discounts phased out by 1992 was used to expand provincial sales of firm energy in 1983 by 12.2% over the 1982 level. Cumulatively these programs contributed to an annual sales increase of 1.7 billion KWh worth $263 million in 1983 (Hydro-Quebec, Vice-presidence Information 1984a: 24-28).

Energy Exports

The utility has been successful in disposing of large blocks of energy annually in an effort to relieve the financial burden imposed by the rapid completion of the La Grande project. This surplus energy condition may continue for up to a decade. Between 1979 and 1983, Hydro-Quebec exported 89.6 billion KWh with a cumulative value of $1.9 billion. United States interests purchased 47.8% of this energy (Hydro-Quebec 1984a: 29). Current projects anticipate the export of 242.7 TWh between 1984 and 1993 (Hydro-Quebec 1983: 67).

Hydro Quebec has attempted to negotiate long-term agreements for the firm sale of surplus energy and power outside the province. A 1982 contract with the New York Power Authority calls for 111 billion KWh over a 13-year period starting in 1984; other agreements with the North East Power Pool permit the exchange of electricity and the sale of up to 33 billion KWh between 1986 and 1997 and another agreement in principle covers the delivery of 70 billion KWh annually for 10 years starting in 1990 (Hydro-Quebec 1984a: 29; 1984b).

In spite of aggressive marketing efforts not all the surplus energy could be sold. Consequently spills were begun in 1982 to dispose of surplus water. Assuming a 2.9%

rate of energy growth between 1981-2001, the equivalent of 52.3 TWh of energy will be spilled between 1983 and 1987 due to the lack of energy markets (Hydro-Quebec 1983: 47).

Due to surplus generation capacity, Hydro-Quebec plans to emphasize capital investments that facilitate the sale of surplus energy over the coming decade. As of 1983 there was 3665 MW of carrying capacity with Ontario, New Brunswick, New York State, and Vermont of which 2765 MW can be used simultaneously. An additional 1940 MW is planned or under construction for completion in 1986. In 1984 the utility invested $100 million to commission the fifth James Bay transmission line and to start preliminary study on the sixth (Hydro-Quebec 1984a: 40; 1983: 12-13). Much of this export transmission capacity was made necessary by surplus diversion-related energy.

A Summary Assessment

Although the James Bay hydroelectric development appears to have been prematurely announced, when the project is compared to earlier diversions some useful innovations were attempted as part of the planning and development process.

1. There was a serious effort to integrate biophysical and social concerns into the project design. Although much of the federal-provincial biophysical studies were started too late in the planning process, some of the data collected were incorporated into engineering design.
2. An adaptive management strategy was adopted following project completion to mitigate and compensate negative effects. The affected Cree played an equal role in deciding where mitigation funds would be spent.
3. As part of the James Bay Agreement, native parties were given a range of rights to various land classes. New institutions created under the agreement have resulted in native groups being treated much like other Quebec communities.
4. Promises made to the affected native parties in the James Bay Agreement were not fulfilled for nearly a decade. The inevitable federal-provincial disputes over responsibilities contributed to these delays.
5. Considerable potential for additional hydroelectric development exists in the James Bay region of Quebec in the Great Whale basin north of La Grande River and in the Nottaway-Broadback-Ruperts basins to the south. Completion of the development of hydroelectric potential in the La Grande basin before moving into either of the basins to the north or south would restrict ecological and social disruption to one system and avoid, as long as possible, major disturbance in the contiguous watersheds.

6. In some instances, roads and infrastructure for diversion-related hydroelectric development might also serve as a component of other resource development initiatives such as forestry, mining, fisheries, or tourism. Integrated planning for such opportunities under federal-provincial Economic and Regional Development Agreements administered by the federal Department of Regional Economic Expansion could create the potential for multiple-purpose use of diversion-related infrastructure in future. Opportunities could be made available to integrate native economic and social development planning into such agreements to the extent the native parties wish to participate.
7. The creation of an enormous surplus of diversion-related hydroelectricity led to programs for electricity consumption which would normally not be adopted: space heating, conversion to electrical boilers, and massive industrial energy subsidies. Under these circumstances, energy conservation cannot be promoted as vigorously as would be desirable. When considered collectively with the necessity to spill unneeded water, overbuilding of the hydroelectric capacity in Quebec has been very costly to the province.

PART C: LESSONS AND POLICY SUGGESTIONS

Interbasin water transfers in Canada are normally components of larger hydroelectricity projects. In 9 of the 10 provinces across the country, Canadians have made use of low divides separating contiguous drainages to concentrate the flow of 2 or more rivers and increase the hydroelectric yield of generating stations. Irrigation, flood control, and municipal uses have been enhanced regionally by smaller diversions. Significant potential remains to divert Canadian water courses. But before doing so serious attention needs to be given to some important questions of science, to the institutional arrangements and jurisdictional questions for choosing and managing these complex projects, and to the criteria and processes which will be used to evaluate the social desirability of potential alternatives. Given the current surplus of hydroelectricity across Canada, there should be no need for further hydroelectric diversions until the end of the century or beyond. This should allow adequate time for a thorough evaluation of the consequences of existing diversions and alternative means of avoiding the need to construct future water transfers as long as possible.

An effort was made to separate recommendations for the federal government from those for the provinces in the following sections. However because of the interjurisdictional nature of most water transfers, the responsibility for approval and operation of diversions is shared and recommendations cannot be readily divided. The experiences to date are equally applicable to federal or provincial lands and decision making responsibilities.

Jurisdiction

Many problems related to management of interjurisdictional rivers can be traced directly to the constitutional division of responsibility for managing natural resources, including water, among the federal, provincial, and territorial governments and the single resource nature of much legislation at each jurisdictional level. For example, the provincial government mandate to develop forestry and mining and the federal mandate to protect anadromous fisheries resources are often in competition. Existing institutional arrangements to bring all interest groups together to reach decisions are sometimes inadequate.

The Canadian federal government was given a comparatively minor legislative mandate to manage water in the Constitution Acts of 1867 and 1982 given the international, interprovincial, and shared provincial-territorial nature of the major Canadian rivers. The most pressing impediment to evaluating and implementing future large interbasin diversions is the absence of an effective interjurisdictional institution to

balance the development plans of, and allocate water and flows among, all political units sharing the same watershed. In the short run, special purpose agreements are essential prior to new major diversions to ensure efficient and equitable developments for all Canadians. If such cooperation cannot be achieved on interjurisdictional rivers a special law capable of resolving conflicts among two or more provincial or federal-provincial jurisdictions will be needed. The federal government should immediately consider with the provinces what alternative mechanisms are capable of promoting coordination and cooperation in the interjurisdictional basins of Canada. Future decisions concerning water transfers should be based on shared knowledge and responsibility, understanding, and effective institutions to resolve disputes and inequities.

Large-Scale Change

Research in the past decade has provided disturbing evidence that interbasin diversions have the potential to cause economically detrimental transfers of biota from one watershed to another and to change the offshore marine environment and regional climates thousands of miles from the projects. A number of scientific studies are needed to enable prediction of the consequences of further diversions.

Biota Transfer: Recommendations

1. In view of the potential threat of biota transfer, Fisheries and Oceans Canada should be instructed and funded to immediately undertake a strategic assessment of the probable ecological consequences of transferring water among the 5 major Canadian continental drainages. In cooperation with the provinces and territories, this work should be staged so that the most probable future diversions are studied initially by a small research team as described in the Canadian water export section below. Due to the complexity and importance of estuarine habitats, special attention should be devoted to the potential of biotic transfers on these areas and the associated consequences. Also much can be learned at comparatively low cost from the continued investigation of existing diversions. This approach would ensure that adequate data are in hand to predict the ecological, social, and economic consequences of biotic transfers before a decision is taken to construct a Canadian diversion which would interconnect any of the 5 continental watersheds, or major river basins within specific watersheds.

Climate and the Oceans

Climatic alterations related to the greenhouse effect changes already in progress threaten to increase temperatures and water needs dramatically throughout southern Canada within a century. Some researchers currently predict that reduction of Arctic

river flows by southward diversions could exacerbate the warming effect in the northern latitudes with unknown consequences. Independent evidence also suggests that alteration of the amount and annual timing of fresh water discharge into marine water bodies by river diversions or dams can alter the physical balance of natural marine coastal processes. Given the uncertainty concerning both these questions of science, immediate attention is warranted to guide decisions related to potential diversions.

Recommendations

1. In view of the potential for rapid global climatic and oceanic productivity changes which might be induced by large-scale transfers of northern flowing waters, Canada should take the initiative to study these questions jointly with the Soviet Union and the United States before massive water transfers from Arctic watersheds to south flowing streams are undertaken in any country. The Scandinavian nations may also wish to contribute to this work.
2. Given the economic importance of fisheries to commerce, tourism, recreation, and subsistence needs in Canada, and the potential significance of climatic change, it is recommended that manpower and funds be allocated by Fisheries and Oceans Canada to the study of river regulation effects on the freshwater and marine environments, particularly in the Canadian Arctic. A small research group should be established to coordinate this work for the Canadian government within the Atmospheric Environment Service and the Inland Waters Directorate of Environment Canada, Fisheries and Oceans Canada, and the affected provinces.

Canadian Water Export

The long standing Canadian federal government policy which has consistently opposed water export without supporting evidence is no longer adequate. It is based on ministerial statements over a number of years that all Canadian waters are currently used and none is available for export. Given the potential of increasing temperatures and increasing water needs in American and Canadian farming areas due to the greenhouse effect, this policy needs to be reassessed.

Unlike other resource sales, water exports need to be considered carefully before commitments are made. As General McNaughton (1966: 17) warned almost two decades ago:

> . . . if we make a bargain to divert water to the United States we cannot ever discontinue or we will face force to compel compliance.

Recommendations

1. In cooperation with the affected provinces and territories, the federal government should instruct environment Canada to select a small number of the most likely potential interprovincial and international donor rivers for hydroelectric and irrigation water projects for initial evaluation. Such work should determine the dependable annual flow, the potential demand for all provincial and territorial instream and diversion uses, and the amount of dependable exportable water surplus if any. The consequences of climatic change on future demand should also be modelled. Detailed economic analysis of alternative projects is not needed at present but research to establish the full range of biophysical, social, and political effects should be estimated.
2. Such a review should establish Canadian water demand and supply scenarios in one or two river basins. This approach would provide data needed for sensitive management of Canadian water resources and lay the groundwork for agreement on appropriation rights among the senior levels of governments on interjurisdictional streams. It would also avoid the need to make a decision based on poor information in future if an offer were made to purchase a large volume of Canadian water.

Some who reviewed a draft of this paper disagreed with these recommendations on the grounds that such a study would signal Canadian agreement with the concept of water export, or that the Americans could wait until sufficient data are collected to reach a decision if an offer to purchase water were made. However, I continue to support the recommendations for two reasons. Such studies are essential to efficient water management provincially and nationally. Secondly, Canadians have entered into disadvantageous agreements with Americans in the past due to a lack of analysis and inadequate public discussion of the consequences of alternative courses of action. The suggested approach would be helpful from both perspectives.

Towards A New Strategy For Managing Hydroelectric Diversions

A Perspective on Accumulating Experience

What can be learned from the 5 projects studied which may be of relevance in planning future diversions? In drawing generalizations it is important to remember that the Ogoki and Long Lake Diversions were planned in the late 1930's, long before the evolution of biophysical and social concerns. It is also noteworthy how small an area and flow were affected north of Lake Superior in comparison to the scale of the Lake Winnipeg, Churchill, and Nelson regulation and diversion schemes. In turn, the James

Bay development is an order of magnitude greater in scale than the Churchill-Nelson. And the Kemano Diversion, built entirely by a private corporation, is significantly different in purpose and design from the other examples.

The first generalizations apply to the Churchill-Nelson and James Bay developments. From an engineering perspective the technology of changing the flow of mighty rivers for energy development has been developed to a predictable and efficient science. Unfortunately, it is also equally true that the science of understanding and predicting the energy needs of society, project costs, and the biophysical consequences of such projects is in its infancy. So is the process of involving those directly affected and potentially disadvantaged by these megaprojects inadequately developed. Indeed, Canadians can not be proud of the cavalier attitude with which hydroelectric utilities and governments have handled the environments, and the people who depend on the environments, which have been affected by major hydroelectric related water transfers. As a result these major projects, conceived and built between the late 1960's and the early 1980's, were drastically overbuilt at enormous cost to the Canadian public.

A major reason for these outcomes is that most diversions have been perceived by provincial utilities and governments as technological and economic challenges. Most planning and development time and effort were devoted to engineering, geotechnical, and economic questions; comparatively little attention was devoted to human ecological and biophysical aspects of projects and this effort came much too late in the planning cycle. Clearly these latter factors played a minor role in the project design and decision making. Although much of the impetus to protect the environment and native parties was promoted by federal agencies and public interest groups, these efforts have been largely ineffective in the Churchill-Nelson for more than a decade following project completion. Conversely, in the La Grande project, specialists in environmental and social sciences were given important planning roles. As a consequence, these matters were handled much more sensitively during the engineering design stage and later when the project became operational by involving the affected natives parties on decision-making bodies to select appropriate remedial measures.

Another disturbing aspect of both projects was the secrecy with which the planning was undertaken. Initially, those to be directly affected were not consulted nor were they informed of what would happen to their environment nor when the change would occur. The publics which ultimately would pay for the projects were not given an opportunity to be briefed and to question the merits of the plans. Nor was there much disclosure and debate in the provincial legislatures from which project details could be released to the public.

A related deficiency in the current institutional system is the inadequacy of federal, provincial, and regional government consultation before decisions are taken pertaining to provincial water resource developments which impinge on federal responsibilities to protect Indian lands, fisheries, and other resources. Both the James Bay and the Churchill-Nelson projects caused heavy federal expenditures for fisheries and other studies and compensation payments to the Indian bands affected. Yet the Department of Indian and Northern Affairs was unable to initially insure that the native parties affected were handled fairly in the decision making process before construction of the diversions. In both the James Bay and Churchill-Nelson examples, the affected communities were given funds to hire technical consultants and lawyers to protect their interests. In the case of fisheries studies, there was inadequate financing for both federal and provincial agencies related to the Churchill-Nelson project to insure that questions of management and science which needed to be answered would be addressed. And many scientists as well as affected Inuit feel there has been inadequate attention paid to the potential impact of both projects on the ecology of Hudson Bay by both the provincial and federal governments.

Enormous progress has been made in dealing with native groups affected by diversions over the past decade. In Quebec, the La Grande Comples Remedial Works Corporation has been innovative in dealing fairly and equitably with the Cree and Inuit; belatedly the federal Department of Indian and Northern Affairs is beginning to address its commitments to the affected native parties. In Manitoba, the responsibility for dealing reasonably with the affected Indian bands has taken much longer but substantial progress has been made on simple questions by the federal and provincial governments and Manitoba Hydro in recent years; but the difficult, expensive class action claims are still outstanding. Progress has been slowest in British Columbia where the bands affected are in the process of formulating a claim for alleged damages suffered when they were rapidly forced to evacuate their lands by the Alcan Diversion more than 30 years ago.

The economic forecasts of project costs and benefits on which the projects were based during the 1970's have caused major problems. Just as in most other sectors of the economy, the downturn in the national and global economy and consequently the demand for energy of the early 1980's was not predicted. And construction costs rose dramatically above expected levels for the Churchill-Nelson and James Bay projects. As a result, when the Churchill Nelson and James Bay projects began to generate enormous quantities of hydroelectric energy, the expected markets in Canada failed to develop and

markets of equivalent value were not available in the United States. Hydro-Quebec and Manitoba Hydro were both forced to sell energy at low rates and Hydro-Quebec has been forced to release an enormous amount of water without allowing it to pass through the recently completed turbines. Provincially, other measures have been adopted in an effort to dispose of surplus energy while long-term export contracts are being arranged. With such a large energy surplus on hand, understandably it has been impossible to aggressively promote conservation programs as a means of progressively reducing the per capita amount of energy needed in future.

A concommitant development in the 1980's was the rapid increase in interest rates and the declining value of the Canadian dollar. Both changes increased the debt servicing costs of the utilities and made amortization of the new diversion-related facilities more expensive than originally expected although the value of firm energy sales to the United States is increased as the value of the United States dollar increases.

In comparison, the smaller Ogoki and Long Lake projects in Ontario which were built in the early 1940's did not experience the same energy demand and repayment problems as the James Bay and Churchill-Nelson developments. They have operated over a four-decade period when energy demand was strong and have produced water and energy reliably. However biophysical and social implications of these projects were basically ignored.

The changing regulatory environment over recent decades has resulted in increasingly sensitive evaluations of alternative developments as well as mitigation and compensation options. It has also been more costly in terms of time and money. Diversion proponents allege that the need to consider a wide variety of factors in project application proposals has made the regulatory process so long that development opportunities are missed. While there is no suggestion that affected interests could legitimately be dropped from consideration, governments must insure that regulatory decisions are reached efficiently and without undue delay. Proponents can reasonably expect that federal and provincial data needs can be defined in advance of field study, that hearings will be coordinated, and that mechanisms will be adopted to insure an appropriate response to submitted documents and proposals. Similarly, it is critical that developers begin their investigations sufficiently early that background data can be collected and development proposals formulated to permit a thorough review and timely approval.

Based on these generalizations a number of potential management strategies to guide future diversions are suggested below.

Policy Suggestions

1. When the federal government is required to comment on future proposals to divert interprovincial or international rivers, a condition for federal approval should be that all alternatives to diversion have been thoroughly explored. This should include consideration of conservation options and pricing of water and electricity to avoid, where possible, the necessity for environmental and social disturbance as well as unnecessary economic costs and public debt.

2. Too much hydroelectric capacity based on interbasin diversions was built too quickly. The James Bay and Churchill-Nelson projects have both demonstrated the dangers of straight line extrapolation of past energy consumption trends. Such consumption forecasts did not consider the effect of energy price increases or reductions in economic growth. While a risk-aversion strategy could potentially result in short periods of energy shortage, it would be far less costly for society to use pricing, conservation, and short-term importation to balance supply and demand. This would permit more energy facilities to operate at or near their safe capacity while returning a reasonable profit on investments and keeping energy rates low for Canadians. Such an approach would have the added advantage of removing some of the boom and bust characteristics from this sector of the construction industry and the related labor force and spreading the demand for new capacity more evenly over time.

3. Export capacity should only be built when firm contracts are in hand to ensure that such investments will be profitable. It is now clear that there is normally a high level of social and ecological disruption associated with a diversion. The price of energy to the importer should reflect the cost of all compensation and mitigation actions, generation and transmission facilities, and the risk of cost and interest rate escalation and a falling Canadian dollar during the construction period which may last up to a decade and over loan amortization periods which normally last even longer. Governments and electrical utilities should attempt to insure a profit over the project life to compensate for all of the risks and opportunity costs involved in constructing diversions. To do so would mean that flexible export agreements are needed so that the price of energy or capacity to consumers can be changed periodically as key economic variables change.

4. The price of energy to domestic consumers should incorporate all of the costs involved in its generation and much more needs to be done to encourage energy

conservation. Such a strategy would decrease the rate at which diversions would be constructed in future.

5. Provincial governments should establish an independent agency in charge of all energy matters. Such a body should have the authority and responsibility to select an appropriate provincial mix of energy sources. They would also insure that adequate energy supplies will be available, electrical utilities are given a clear and unequivocal mandate, and that technical, economic, biophysical, and social concerns and conservation opportunities all receive an appropriate level of attention during the planning, development, and operation of diversions. For example, the recent Site C hearings held by the British Columbia Utilities Commission is an example of the value of full disclosure in public decision making which is worthy of potential study for partial use by other provinces.

6. A similar provincial agency is needed to inventory water resources, prepare demand and supply forecasts, and allocate water among competing uses within individual basins and among basins competing for the same potential water supplies by diversion. The innovative South Saskatchewan River Basin Planning Program in Alberta deserves careful analysis as a potential planning approach to place a priority on competing water uses and to select among development alternatives and areas for future water use (Alberta 1984).

7. Sincere attention needs to be directed to the problems and opportunities of local residents disrupted by diversions early in the development process. Particularly in remote areas where native bands are unfamiliar with southern institutions, customs, and language, a long lead time is necessary for education, negotiation, planning, and compromise. Serious effort should be made to arrange agreements and monitoring arrangements before construction begins so that problems which emerge during construction and operation can be corrected, mitigated, or compensated within a reasonable period based on careful review of operating experience.

8. The style of future settlements with native groups should be based on negotiation and compromise rather than the legalistic confrontational approach adopted initially in the Churchill-Nelson and James Bay agreements. It is now clear that when treated unjustly, Indian groups can use the legal system to halt construction

and engage utilities and governments in costly litigation. When treated unfairly the natives become suspicious and distrustful of the energy utilities and governments, lawyers are hired by all parties, and a disproportionate amount of public funds are spent on legal fees rather than to assist those directly affected by diversions. Under such circumstances, the discussion of simple issues is made difficult or possible.

9. Future agreements with Indian groups and others affected by diversions require a variety of components to be successful. Required compensation and mitigation measures should be clearly described as well as a timetable for implementation objectives. Funds must be set aside by governments over and above existing allocations to agencies to undertake the necessary work, specific people must be designated as being responsible to complete the agreed actions, provision must be made for reporting progress on required tasks to the responsible minister, and a legally binding impartial conflict resolution mechanism is needed to resolve disputes when parties to the agreement can not agree. Finally an adaptive mechanism should be created to respond quickly to unforeseen developments as experience gained from constructing and operating a diversion permits a more realistic appraisal of the full range of consequences to be experienced.

10. Federal and provincial affirmative action legislation is needed to insure that northern residents affected by diversions are given the opportunity to obtain employment on future projects. Advanced training will be required in some cases so that those who wish such work are qualified to participate.

11. The La Grande Complex Remedial Works Corporation (SOTRAC) joint decision making approach involving the Cree and the James Bay Energy Corporation is a promising model to deal with emerging problems where rapid adaptation to project changes is necessary. And the Quebec Cree and Inuit deserve careful study to determine the rate at which native groups can assume control over their local and regional governments, education, health care, legal, transportation, economic development systems, and the kinds of training they will need to conduct this work efficiently.

12. Early public discussion and strategic planning are needed to develop long term policies for northern rivers which potentially could be modified by diversions.

Gradual attrition of resources such as canoe routes followed by trappers and fur traders, trading posts, native artifacts, white-water canoeing opportunities, fish habitats, mineral deposits, and the esthetic beauty of natural landscapes should be minimized. River development should be confined to designated watersheds and others should be permitted to evolve under natural processes.

13. When hydroelectric and other diversions start to function, there is a need to establish operations committees composed of all major water users and regulatory agencies to ensure the needs of all users are accommodated in the operation of the diversion to the greatest extent possible. In some cases, for example, the requirements of vulnerable uses such as fish habitat or cariboo migration must be met before others such as hydroelectricity generation. Such committees should draw upon existing government agencies to the extent possible to avoid proliferation of decision making bodies.

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APPENDIX I

PROCEEDINGS OF THE WATER TRANSFER AND EXPORT WORKSHOP

Sponsored by the Inquiry on Federal Water Policy

31 January and 1 February 1985
Vancouver, B.C.

An interdisciplinary group of developers, government and crown corporation professionals, and academics (Appendix II) met in Vancouver to evaluate a preliminary draft of the Canadian Interbasins Diversions paper and to discuss basic questions related to the accumulating Canadian diversion experience. A consensus of the group on a number of questions was possible but an important additional contribution was the individual experience, analytical methods, and points of view of many participants experienced in the design, operation, and investigation of diversions. With such a broad spectrum of backgrounds, it was inevitable that disagreement surfaced concerning the value of some diversions and whether they would be constructed again, or differently, given the advantage of hindsight information. In general, developers tended to believe that past projects would be constructed in basically the same way today as they were initially with only minor modifications; other participants disagreed with this perspective believing that fundamental change would be warranted in project design.

Many ideas expressed in the workshop were integrated into the main body of the report. The brief discussion which follows highlights some additional important issues raised in discussions and subsequent correspondence.

Changing Social Values

Over time, the values which society places on different resources such as fish, forestry, or undisturbed valleys can change dramatically. This poses a potential problem for analysts and proponents, particularly where projects are divided into two or more development phases. At one point in time, certain changes attributable to the loss of fish stocks, provincial parks, or drowned valleys may be acceptable to society; decades later the same type of development might generate a vociferous outcry by a subset of citizens unalterably opposed to the continuation, or completion, of a project as initially designed.

The situation could pose major problems for governments and project proponents. If decades pass before a project is completed, the government currently in power might not wish to proceed under the terms of a contract issued long before its period of tenure. Similarly, citizens in the jurisdiction involved may disapprove of certain aspects of the new project which previously would have been acceptible. While the proponent managers' views may have changed dramatically in the intervening years, they may not be compatible with the evolved values of the public and governments toward the project. Thus the decision to break diversions into sequential parts could lead to completion problems at a later date due to social value changes over time.

Biophysical Changes

Sufficient understanding is now available within the regions where diversions have been constructed previously to predict most aspects to be affected, and the direction of change to be expected, if not to the level of precise details, by future interregional water transfers. However major diversions often affect such large areas that remedial mitigation work would be inordinantly expensive to implement. Where a diversion is the best means of achieving a set of objectives, a better solution is to attempt to avoid such problems by sensitive engineering in the design stage and then to compensate for minor residual problems.

The degree of mitigation that can be undertaken is normally related to the scale of diversion involved. In the James Bay project a $125 million canal and $30 million dikes were constructed to transfer water from the Caniapiscau basin to the La Grande. This level of expenditure was reasonable to avoid ecological disruption given the $14.6 billion scale of the project. Conversely, such an adjustment would normally be too costly for smaller projects.

It was suggested that in attempting to reach a judgement on the desirability of a proposed diversion, the concept of marginal impacts may be useful. In comparing the range of alternative strategies available to achieve some social goal, the sum of the negative impacts of alternatives can be compared. For example, a water tax, water pricing, conservation, and a small project might be alternatives to large proposed hydroelectric or irrigation diversions.

Social Change

It has been suggested that 5 to 10 years is needed to prepare Indian bands for the potential change which could be associated with development. Some participants questioned the degree to which massive physical change associated with diversions can be explained to those to be affected over any period. When a beaver dam is the only comparable structure experienced previously, a larger power station with river discharge more than doubled, and changed seasonally, is beyond comprehension. Even more disturbing for native parties is the boom and bust nature of massive infusions of cash during the construction period, which may last up to a decade and then no work following project completion. How many will wish to return to the land after such a period of involvement in a cash economy? What would be a suitable set of adjustments to ease the shock for those affected and over what period of time would they be needed? These questions deserve careful consideration before another diversion is constructed in the north.

Compensation Payment Royalties For Those Affected by Project

When diversions are constructed on crown lands, project proponents believe that royalty payments, for example based on water rentals, hydroelectricity generated, or products fabricated, are unwarranted. However, royalty payments of various kinds may be appropriate where aboriginal land claims settlements are involved. It was felt that normally compensation payments should not exceed the value of the resource loss attributable to a diversion. These payments are intended to facilitate the transition to a new occupation by those detrimentally affected by a project due to the destruction of the resource base or the means of livelihood.

Compensation payments to native parties for losses experienced should normally be staged over a number of years, particularly when the groups involved are not familiar with a cash economy. This permits a period of training and adjustment so that the funds involved will not be spent indiscriminately before the necessary investment and money management skills are learned.

Another form of compensation is to adopt a preferential hiring policy which favors those living in the project area for both work and training. It was stressed that there should be freedom of choice among life styles. Local residents could be given the opportunity to take part in a 3-week training period for relatively low paying laborers positions on job sites and then return to the traditional way of life following project construction. Alternatively, some may choose to work as apprentices to obtain more advanced training as electricians, carpenters, or pipefitters. In this way, those locally disadvantaged by diversions are given the option of retraining for entirely new occupations and subsequently they may choose to relocate in other parts of the country. Alternatively, others may wish to retain their traditional occupations after the project is completed and they would be allowed to do so.

Appropriate Compensation

The question was raised as to whether Indian bands detrimentally affected by development projects are given a comparatively higher level of compensation than other Canadians living in southern Canada who are similarly disadvantaged by development projects. Pickering and Mirabel airports were cited as examples where agricultural land was expropriated and families forced from their farms with comparably low levels of compensation.

There are obviously no easy answers to this question. A mitigating factor would appear to be that Indian bands have developed a specialized set of skills and knowledge to

enable them to make a living from the land. However, they often lack knowledge of English, French, or both languages, and are unfamiliar with southern institutions and customs. As a result, a southerner forced to leave one farm or position could probably find alternative employment; an Indian band clearly needs greater compensation if their means of livelihood is destroyed and an equivalent area is not available for resettlement as they may not have the skills needed to earn a living in the southern economy.

Residual Risk and Uncertainty

There will be unpredictable events in most projects and a strategy is needed to accommodate such questions based on skillful engineering. It is critical that investigations of project effects begin early enough so that all variables capable of mitigation are handled in project design. Contingency planning is increasingly recommended as an approach to residual uncertainty so that alternative strategies can be adopted in advance and that the proponent is clear on the levels and kinds of remedial actions that might be required depending on the way affected ecosystems respond to a project. However such an approach may not be favored by private companies because of the uncertainty involved. Firms prefer to know the upper limit of potential compensation before a decision is taken to begin a diversion.

A suggested alternative approach to the question of uncertainty concerns the significance of change to be induced by a project. One participant suggested it would be sufficient to estimate the worst possible level of potential damage and to use such information in reaching a decision on whether to proceed with development in association with appropriate levels of compensation and mitigation. The advantage of such an approach is the certainty of potential costs for the developer. However, the unresolved question of who pays the cost of additional compensation if the original estimates are inaccurate was not addressed.

Data Collection: Private or Public?

There has been an increasing move in the 1970's to transfer much of the responsibility for data collection to the development proponent. This is reasonable, especially in the immediate vicinity of a project. However, it is not realistic to expect crown and private corporations to be required to collect broad regional data, or to investigate the cumulative impacts of a wide variety of independent actions, which could affect the environment and many interest groups. Moreover, corporate value systems may not reflect social values. For these reasons it is essential that an efficient cadre of federal and provincial scientists are available to comment on the interpretation of project-specific data collected by corporations as well as the regional implications of proposed developments and cumulative impacts.

Some experience to date suggests that the developer may be the most reliable body to collect a reasonable range of data from the immediate project area. Governments rarely will guarantee monitoring funding for 5 to 10 years following project completion; university faculty are often too concerned with emerging research fields and normally will not devote a decade of research to one topic.

Project Monitoring

There are several important reasons to monitor major biophysical and social changes induced by diversions. By documenting what actually happens to affected systems, the accuracy of past predictions can be determined and unexpected developments highlighted for further investigation. In this manner, the accuracy of scientific understanding, models, and predictions are improved to enable more precise and efficient appraisal of future project proposals.

In other circumstances monitoring is necessary to efficiently operate existing projects. For example, it may be critical to know when mercury which accumulates in new reservoirs and associated fish decreases in concentration to levels safe for consumption.

Experience from each major project should be synthesized in some form which is widely available to scientists and engineers to assist in evaluating and designing similar projects in future. Periodical literature, government publications, or symposium volumes are all appropriate vehicles for disseminating this information. In some instances, government agencies could provide a valuable public service by compiling such experience in central data banks.

Modelling Change

Considerable experience has accumulated in using models to predict change. The lesson from the James Bay projects is that knowledgable and experienced scientists and engineers can predict the consequence of change initially at reasonable cost. However, increasingly precise predictions become comparatively costly for the small incremental gain in predictive power. Indeed, the insights available from hindsight assessments of existing diversions is often a more economical method of generating similar predictions than the development of complex theoretical models based on imprecise understanding of the ecosystem involved.

Recent Soviet Developments (Philip P. Micklin)

The Soviet Union is about to embark on water diversions on a scale which is unprecedented in human history. Decades of study and debate have defined the

possibility of overcoming water shortages in agricultural regions along the lower Volga, in Kazakhstan, and Central Asia as well of to alleviating falling water levels in southern seas by transferring water south from Arctic rivers. The environmental consequences of these projects have been under study for years (Micklin 1983; Kelly et al. 1983).

European Diversions. The first phase of European diversions would transfer 6 km^3/yr by 1990 and 20 km^3/yr by 2000. Part of this project would divert 5 km^3/yr from the Volga River to the Don River to improve ecological conditions in the Azov Sea; it would also stabilize the Caspian Sea level (Micklin 1983).

Siberian (Midland) Diversions. Planning is underway to transfer more than 27 km^3/yr from the Ob to the Amadar'ya River by pumping water 110 m over the divide between Western Siberia and the Turah Lowland over a 2500 km route. If approved, the project could begin carrying water between 1995 and 2000 (Micklin 1983).

APPENDIX II

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